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NATIONAL DAM SAFETY PROGRAM. MACOPIN RESERVOIR DAM (NJ00320), P--ETC(U)
MAY 80 J P TALERICO DACW61-79-C-0011

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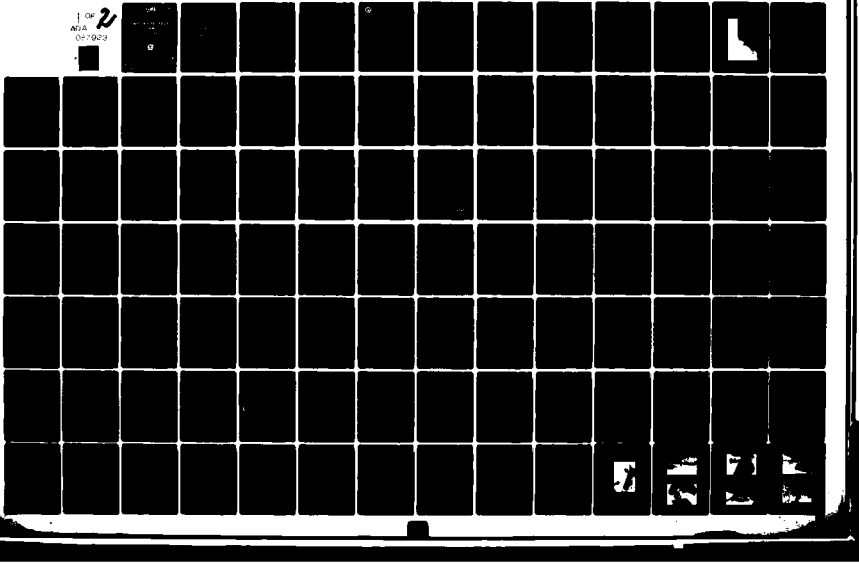


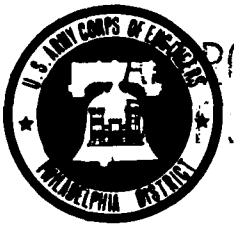
LEVEL II

AD A087923

PEQUANNOCK RIVER, PASSAIC COUNTY
PASSAIC RIVER BASIN
NEW JERSEY

# MACOPIN RESERVOIR DAM
# NJ 00320

## PHASE 1 INSPECTION REPORT
## NATIONAL DAM SAFETY PROGRAM









DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

DACW61-79-C-0011

MAY 1980

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| 4. TITLE *(and Subtitle)*: Phase I Inspection Report<br>National Dam Safety Program<br>Macopin Reservoir Dam NJ00320<br>Passaic River Basin, New Jersey | 5. TYPE OF REPORT & PERIOD COVERED: FINAL |
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Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Dams
Embankments
Visual Inspection
Struttural Analysis
National Dam Safety Program
Macopin Reservoir Dam, New Jersey
Spillways

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
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CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

(1)

IN REPLY REFER TO
NAPEN-N

05 AUG 1980

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Macopin Reservoir Dam in Passaic County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Macopin Reservoir Dam, a high hazard potential structure is judged to be in good overall condition and the dam's spillway is considered adequate. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The owner should develop an emergency action plan outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months from the date of approval of this report.

b. The following remedial actions should be initiated within twelve months from the date of approval of this report:

(1) Acquire foundation data by a boring program to determine the spillway and high dam foundations and determine the dam's masonry, earth and rock engineering properties.

(2) Determine the uplift pressures by piezometers at various points along the base of the dam including points along the heel and toe of the dam.

(3) Determine the silt levels adjacent to the dam's heel.

(4) Replace the missing stones and re-grout those areas that have grout missing in the downstream side of the spillway.

NAPEN-N
Honorable Brendan T. Byrne

(5) Repair all cracked and spalled concrete in the top of the spillway and the high dam.

(6) Repair or replace the defective low-level outlet blow-off valve.

(7) All debris should be removed from the spillway discharge channel.

c. The existing dam plans and drawings should be annotated and updated to form a coherent as-built set within two years from the date of approval of this report.

d. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam within one year from the date of approval of this report.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Roe of the Eighth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

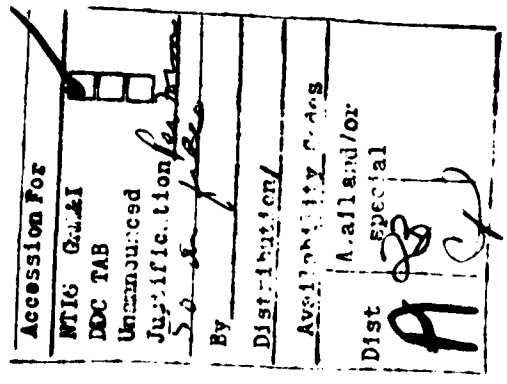
Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. 29
Trent



## MACOPIN RESERVOIR DAM (NJ00320)

## CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 21 November and 4 December 1979 by Harris - ECI Associates, Inc., under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Macopin Reservoir Dam, a high hazard potential structure is judged to be in good overall condition and the dam's spillway is considered adequate. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The owner should develop an emergency action plan outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months from the date of approval of this report.

b. The following remedial actions should be initiated within twelve months from the date of approval of this report:

(1) Acquire foundation data by a boring program to determine the spillway and high dam foundations and determine the dam's masonry, earth and rock engineering properties.

(2) Determine the uplift pressures by piezometers at various points along the base of the dam including points along the heel and toe of the dam.

(3) Determine the silt levels adjacent to the dam's heel.

(4) Replace the missing stones and re-grout those areas that have grout missing in the downstream side of the spillway.

(5) Repair all cracked and spalled concrete in the top of the spillway and the high dam.

(6) Repair or replace the defective low-level outlet blow-off valve.

(7) All debris should be removed from the spillway discharge channel.

c. The existing dam plans and drawings should be annotated and updated to form a coherent as-built set within two years from the date of approval of this report.

d. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam within one year from the date of approval of this report.

APPROVED: _____

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: _____

PASSAIC RIVER BASIN

PEQUANNOCK RIVER, PASSAIC COUNTY

NEW JERSEY

# MACOPIN RESERVOIR DAM

NJ00320

# PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY

PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

PHILADELPHIA, PENNSYLVANIA 19106

MAY 1980

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

| | |
|---|---|
| Name: | Macopin Reservoir Dam, I.D. NJ 00320 |
| State Located: | New Jersey |
| County Located: | Passaic County |
| Stream: | Pequannock River |
| River Basin: | Passaic River |
| Date of Inspection: | November 21 and December 4, 1979 |

## Assessment of General Conditions

Macopin Reservoir Dam is a stone masonry gravity dam with gunite facing on the upstream side of the dam. The overall condition of the dam is good. The dam is comprised of four sections: a non-overflow wingwall, a gate house, an overflow spillway and a high dam. Looking downstream from the reservoir and from left to right; the wingwall is at the left end of the dam, then the gate house, spillway and high dam. There are five stones missing in the downstream side of the spillway and there are some areas between the stones that need regrouting. There are some longitudinal cracks in the concrete coping of the spillway and dam. Spalling was also noticed in the concrete coping of the spillway and dam. The downstream channel is well defined. The operation of the low-level outlet was satisfactorily demonstrated. However, there are seven low-level blow off valves along the left bank of the downstream channel that could not be operated during inspection because a wrench was not available to demonstrate operation of the valves. But, according to the owner, six of the seven valves operate satisfactorily. The hazard potential is rated "high".

The spillway capacity of Macopin Reservoir Dam is considered adequate in view of the ability of the spillway to pass the SDF without overtopping the dam.

The dam's stability is in question since it apparently was designed without considering uplift forces on the base plane. A preliminary evaluation of the stability of the dam shows that it would have difficulty in meeting current Corps of Engineers' stability guidelines at maximum pool elevation. However, the dam has safely passed the 1903 flood, which was only 0.7 feet lower than the computed maximum pool elevation. The following actions are recommended along with a timetable for their completion. All recommended actions should be conducted under the supervision of an Engineer who is experienced in the design, construction and inspection of dams.

1. Acquire foundation data by a boring program to determine the spillway and high dam foundations and determine the dam's masonry, earth and rock engineering properties within twelve months.

2. Determine the uplift pressures by piezometers at various points along the base of the dam including points along the heel and toe of the dam within twelve months.

3. Determine the silt levels adjacent to the dam's heel within twelve months.

4. Replace the missing stones and re-grout those areas that have grout missing in the downstream side of the spillway. This work should be completed within twelve months.

5. Repair the spalling and the longitudinal cracks in the top of the spillway and the high dam. This work should be completed within twelve months.

6. Repair or replace the defective low-level blow off valve. This should be completed within twelve months.

7. Remove the debris from the spillway discharge channel within twelve months.

8. The owner should develop an emergency action plan (if one is not already available) outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months.

Furthermore, while of a less urgent nature, the following additional actions are recommended and should be carried out within twenty-four months.

1. Conduct a complete topographic survey of the dam and surrounding area, in order to develop a detailed plan and several cross-sections of the dam. Annotate and update the existing drawings, and form a coherent as-built set.

2. The owner should develop within one (1) year after formal approval of the report, written operating procedures and a periodic maintenance plan to insure the safety of the dam.

John P. Talerico

John P. Talerico, P.E.
HARRIS-ECI ASSOCIATES

Photo taken on February 15, 1980

MACOPIN RESERVOIR DAM

View - from gate house - of the spillway, a portion of the reservoir and the high dam. Visible at upper right, beyond the high dam, is Southbound Route 23 traffic.

# PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the office of the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

MACOPIN RESERVOIR DAM, I.D. NJ 00320

# SECTION 1

## 1. PROJECT INFORMATION

### 1.1 General

#### a. Authority

The National Dam Inspection Act (Public Law 92-367, 1972) provides for the National Inventory and Inspection Program by the U.S. Army Corps of Engineers. This inspection was made in accordance with this authority under Contract C-FPM No. 35 with the State of New Jersey who, in turn, is contracted to the Philadelphia District of the Corps of Engineers, and was carried out by the engineering firm of Harris-ECI Associates, Woodbridge, New Jersey.

#### b. Purpose of Inspection

The visual inspection of Macopin Reservoir Dam was made on November 21, 1979. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam, embankment and its appurtenant structures.

#### c. Scope of Report

The report summarizes available pertinent data relating to the project; presents a summary of visual observations made during the field inspection; presents an evaluation of hydrologic and hydraulic conditions at the site; presents an evaluation as to the structural adequacy of the various project features; and assesses the general condition of the dam with respect to safety.

### 1.2 Description of Project

#### a. Description of Dam and Appurtenances

Macopin Dam is a stone masonry gravity dam with gunite facing on the upstream side. It has a maximum structural height of 34.0 feet and an overall length of 434 feet. The dam is comprised of four sections: a non-overflow wingwall, a gate house, an overflow spillway and a high dam. The wingwall, located at the left end of the dam, is 55 feet long and connects the gate house to the Route 23 Northbound embankment. The top of the wingwall is 10.5 feet above the spillway crest. The spillway is

a 270 foot long, 17 foot high arc-shaped overflow that connects to the gate house at the left end of the dam and to the high dam at the right. The slope of the downstream face of the spillway is 1H:6V and the upstream face is nearly vertical. The high dam is 164 feet long and extends from the right end of the spillway to the embankment of N.J. Route 23 Southbound. The crest of the high dam section has a width of 6.5 feet and is 7.0 feet above the spillway crest. The slope of the upstream face of the high dam is nearly vertical while the downstream face has a nearly vertical slope from the top down to the spillway crest elevation, and from there the same as the spillway (1H:6V). The upstream face of the entire dam has an approximate 2-inch thick coating of gunite.

The gate house at the left end of the dam serves as an inlet chamber for the low-level outlet control valves and conduits. The flow enters the gate house through two masonry tunnels 10 ft. wide x 11 ft. high. The flow exits the gate house through two 48-inch steel pipes and discharges into the Pequannock River just downstream of the gate house through seven 16-inch blow-off valves. There are ten sluice gates within the gate house for the purpose of controlling the water flow and isolating the filter screens for servicing.

The flow from the spillway and the gate house discharge directly into the Pequannock River which flows down the median of Route 23 crossing under a turn around, through a 30 ft. wide by 13 ft. high opening, about 600 feet from the spillway. From there the river continues down the median until it crosses under Route 23 Southbound approximately 3,400 feet from the spillway.

There are no known borings or test pits taken for this dam.

A generalized description of soil conditions is contained in Report No. 3, Passaic County and Report No. 9, Morris County, Engineering Soil Survey of New Jersey, by Rutgers University. The reports, dated 1951 and 1953, describe the Passaic County section as ground moraine deposited during the Wisconsin glaciation. Ground moraine is unstratified, heterogeneous material including clay, silt and sand sizes, with varying amounts of gravel, cobbles and boulders. The underlying Gneiss is variable in depth but usually shallow. The Morris county map describes its section as Gneiss rock. Geologic Overlay Sheet 22 further describes the rock as Hyperstene-Quartz-Andesine Gneiss.

b. Location

Macopin Reservoir Dam is located on the Pequannock River in the Township of West Milford, Passaic County, New Jersey. It is accessible by way of N.J. Route 23.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Department of the Army, Office of the Chief Engineers, the dam is classified in the dam size category as being "small", since its storage volume of 162 acre-feet is less than 1,000 acre-feet. The dam

is also classified as "small" because its height of 34.0 feet is less than 40 feet. The overall size classification of Macopin Reservoir Dam is classified as "small" in size.

d. Hazard Classification

A hazard potential classification of "high" has been assigned to the dam on the basis that a hypothetical failure would result in excessive damage to Route 23 immediately downstream of the dam. Because the road is very heavily traveled, the possibility exists of the loss of more than a few lives in the event of dam failure.

e. Ownership

Macopin Reservoir Dam is owned by:

City of Newark
Department of Public Works
Division of Water Supply
1294 McBride Avenue
Little Falls, N.J. 07424

Attention: Mr. Daniel Berardinelli
(201) 256-4965

f. Purpose

Macopin Reservoir Dam is presently used for storage to provide the let-down requirement to satisfy the minimum stream volume of the Pequannock River.

g. Design and Construction History

There is no data on the actual construction dates of the Macopin Dam. Plans were developed during May to August 1892 but it is not known whether it was built at this time.

The sequence of plans available does give some insight into the history of the dam. It appears that siltation may have been a problem at one time. In 1930 there is a plan showing mud deposits in the reservoir. Before the construction of the Charlotteburg Dam, circa 1961, the existing upstream reservoirs did not have proper impounding capacity in relation to the size of their drainage areas. As a result, water was wasted over the Macopin Reservoir Dam before the upstream reservoirs were filled. Water from these upstream dams flowed to Macopin Reservoir Dam in open channels. The scouring and erosive action of the stream flow on these channel banks and bottoms resulted in a muddied water full of sediment. This was deposited as mud when the stream velocity was reduced by the dam blockage and the widened reservoir. What remedial action to prevent or remove these deposits is not known.

A construction plan dated 1940 shows procedures for guniting the upstream faces of the spillway, dam, gate house and wingwall. Also noteworthy on

this plan, is that it shows a stone retaining wall, seven 16-inch blow-off valves and an added 48-inch conduit. These were not shown on the 1892 plans.

In 1944 a construction plan indicates some revamping of the screen guide system in the front 10 feet wide x 11 feet high chambers. The center-guides and columns were scheduled to be removed and new screens were to be installed in the wells.

A major revision occurred in 1946. Additional electrical equipment was installed in the gate house and a water treatment plant and its appurtenances were built downstream.

The construction of Charlotteburg Dam (NJ00316), circa 1961, permitted by passing of the Macopin Reservoir. A 72-inch concrete pipe diverts water past Macopin into two 48-inch riveted steel existing aqueducts.

h. Normal Operating Procedures

The discharge from the reservoir is normally unregulated and is allowed to naturally balance the inflow into the lake. The reservoir is occasionally drawn down via the blow-off valves for cleaning and inspection purposes. Also, the blow-off valves are used to release water into the Pequannock River to satisfy the required stream-flow volume.

1.3 Pertinent Data

a. Drainage Area — 63.7 sq. mi.

b. Discharge at Dam Site

| | |
|---|---|
| Ungated spillway capacity at elevation of top of dam: | 17,602 cfs (590.74 NGVD) |
| Total spillway capacity at maximum pool elevation (SDF): | 8,763 cfs (588.14 NGVD) |

c. Elevation (Feet above NGVD)

| | |
|---|---|
| Top of dam (High dam): | 590.74 |
| (Non-overflow wingwall): | 594.24 |
| Maximum pool design surcharge (SDF): | 588.14 |
| Recreation pool: | N/A |
| Spillway crest: | 583.74 |
| Streambed at centerline of dam: | 562.0 (estimated) |
| Maximum tailwater: | 566.0 (estimated) |

d. Reservoir

| | |
|---|---|
| Length of maximum pool: | 2,100 ft. (estimated) |
| Length of recreation pool: | 2,000 ft. (estimated) |

e. Storage (acre-feet)

| | |
|---|---|
| Spillway Crest: | 101.0 |
| Top of dam: | 206.0 |
| Maximum pool (SDF): | 162.0 |

f. Reservoir Surface (acres)

| | |
|---|---|
| Top of dam: | 16.5 (estimated) |
| Maximum pool (SDF): | 13.9 (estimated) |
| Spillway Crest: | 12.3 (estimated) |

g. Dam

| | |
|---|---|
| Type: | Stone masonry gravity with gunite facing on upstream side. |
| Length: | 434 ft. (effective) |
| Height: | 34 ft. |
| Top width: | 6.5 ft. |
| Side slopes - Upstream: | Nearly vertical |
| - Downstream: | Nearly vertical to 1H:6V |
| Zoning: | Unknown |
| Impervious core: | N/A |
| Cutoff: | None |
| Grout curtain: | Unknown |

h. Diversion and Regulating Tunnel

N/A

i. Spillway

| | |
|---|---|
| Type: | Stone masonry gravity with gunite facing on the upstream side. |
| Length of weir: | 270 ft. |
| Crest elevation: | 583.74 |
| Gates: | None |
| U/S Channel: | Macopin Reservoir |
| D/S Channel: | Natural channel with rock ledge |

j. Regulating Outlets

| | |
|---|---|
| Low level outlet: | 2 - 48-inch steel pipes with 7 - 16-inch blow-offs on the 48-inch pipe on the right. |
| Controls: | Ten sluice gates |
| Emergency gate: | None |
| Outlet: | 569.2 NGVD |

# SECTION 2

## 2. ENGINEERING DATA

### 2.1 Design

Drawings for the original construction of Macopin Reservoir Dam in the early 1890's and the modifications in the 1940's, are available from the City of Newark, Division of Water Supply, offices on McBride Avenue in Little Falls, N.J. No data from soil borings, soil tests, or other geotechnical data is available. Data concerning the hydraulic capacity of the spillway is also unavailable.

### 2.2 Construction

Data is not available concerning the as-built construction of the dam. No data exists of the construction methods, borrow sources, or other data pertinent to the construction of the dam.

### 2.3 Operation

Daily records have been kept since 1898 of the water level in the reservoir. The water level indicator was inspected and found in satisfactory condition.

Presently Macopin is used only for the purpose of providing the required stream flow volume for the Pequannock River.

### 2.4 Evaluation

#### a. Availability

The availability of engineering data is fair. The stated drawings and verbal information concerning the original construction and the subsequent modifications can be obtained from the Manager's Office, Division of Water Supply, listed above under Section 2.1.

#### b. Adequacy

The engineering data available, together with that obtained in the field, were adequate to perform hydrologic and hydraulic computations. The data was sufficient with certain assumptions to perform a preliminary stability analysis. Combining this with the visual observations, a preliminary evaluation could be made.

c. Validity

Information contained in the drawings and checked by limited field measurement appears to be valid.

# SECTION 3

## 3. VISUAL INSPECTION

### 3.1 Findings

#### a. General

The visual inspection of Macopin Reservoir Dam revealed the dam and spillway to be in good condition, but in need of minor repairs. The reservoir level was below the spillway's crest at the time of the inspection.

#### b. Dam

The stone masonry gravity dam appears sound. Longitudinal cracks and spalling were noticed in the concrete cap of the dam. A non-overflow wingwall, located at the left side of the dam, extends from the gate house to the Northbound embankment of Route 23. The wingwall is in good condition. Gunite facing is on the upstream side of both the dam and wingwall. The gunite facing is in good condition. No misalignment of the dam or wingwall in the horizontal or vertical plane was evident. All visible construction joints appeared in good condition. No seepage or leakage was evident.

#### c. Appurtenant Structures

##### 1. Spillways

Longitudinal cracks and spalling were noticed in the concrete coping of the spillway. The downstream side of the concrete spillway has stone masonry. Five of these stones, located in the first two layers down from the coping, were missing. Grout was also missing between some areas of the stones. The vertical and horizontal alignment of the crest was good. The spillway discharge channel is in good condition. It has a rock bottom.

##### 2. Outlet Works

Two 48-inch steel pipes serve as the low level outlet at the downstream side of the gate house located at the left end of the dam. Ten valves and sluice gates, located in the gate house, control the flow through these pipes. All ten of the valves operated satisfactorily. The valve operators of all ten valves were in good condition. The sluice gates were submerged and not visible. Seven low level blow-off valves were observed along the left bank, downstream of the spillway. The valves are buried with extended stems for wrench operation. A wrench was not available to demonstrate operation of the valves. According to the owner, six of the seven valves operate satisfactorily. All seven of the valves are

connected to one (the one on the right side) of the 48-inch steel pipes. The stilling basin is natural rock in good condition.

d. Reservoir Area

There is a concrete crib wall on the reservoir's right side (southbound embankment of Route 23). Slopes on the reservoir's left side are flat to moderate. There is no indication of slope instability.

e. Downstream Channel

The discharge from the spillway veers right about 90 degrees, or parallel to the spillway, to a point where the dam begins. From this point the channel turns left, also about 90 degrees, flowing downstream in the median between the embankments of Route 23 Northbound and Southbound. The channel is in good condition. Some boulders, fallen trees and debris are on the bottom of the channel.

There is a stone retaining wall that begins at the gate house, left side of the dam, and extends for about 140 feet along the embankment of Northbound Route 23. It is in good condition.

Approximately 600 feet from the spillway the channel flows under a bridge that carries traffic making U-turns from both Northbound and Southbound Route 23. The first house downstream, about 2.5 miles from the spillway, is on the channel's right bank and on the outskirts of the City of Butler.

# SECTION 4

## 4. OPERATIONAL PROCEDURES

### 4.1 Procedures

Macopin Reservoir Dam is used to impound water to provide the minimum stream flow requirement for the Pequannock River. The level in the reservoir is maintained through the unregulated flow over the spillway.

### 4.2 Maintenance of the Dam

There is no regular inspection and maintenance program for the dam and appurtenant structures. Every few years the reservoir is drawn down for cleaning and inspection.

### 4.3 Maintenance of Operation Facilities

The low-level outlet operating facilities consist of 10-sluice gates within the gate house and 7-blow-off valves downstream of the gate house. At the time of inspection, the operation of the sluice gates was demonstrated satisfactorily. The operation of the blow-off valves could not be demonstrated since a wrench was not available to open the valves. After the inspection, the Superintendent, Newark Water Supply, verbally informed the inspectors that six of the seven valves were operable.

### 4.4 Evaluation

The present operational and maintenance procedures are fair with the dam and spillway being maintained in a serviceable manner.

# SECTION 5

## 5. HYDRAULIC/HYDROLOGIC

### 5.1 Evaluation of Features

#### a. Design

The drainage area above Macopin Reservoir Dam is approximately 63.7 square miles. A drainage map of the watershed of the dam site is presented on Plate 1, Appendix D.

The topography within the basin is moderately sloped. Elevations range from approximately 1,437 feet above NGVD at the north portion of the watershed to about 590 feet at the dam site. Land use patterns within the watershed are mostly woodland.

The evaluation of the hydraulic and hydrologic features of Macopin Reservoir was based on criteria set forth in the Corps Guidelines and additional guidance provided by the Philadelphia District, Corps of Engineers. The Spillway Design Flood for the dam is equal to the 1/2 PMF.

The 5-hour PMF inflow hydrograph for Macopin Reservoir Dam was also provided by the Philadelphia District, Corps of Engineers. The inflow hydrograph is directly input to obtain PMF and various ratios of PMF utilizing program HEC1-DB. The 5-hour PMF inflow hydrograph is given in Appendix D.

The SDF peak outflow calculated for the dam is 8,763 cfs. This value is derived from the 1/2 PMF. The 1/2 PMF was routed through the dam and it was found the dam would not overtop.

The stage-outflow relation for the spillway was determined from the geometry of the spillway and dam, utilizing HEC1-DB program.

The reservoir stage-storage capacity relationship was computed directly by the conic method, utilizing the HEC1-DB program. The reservoir surface areas at various elevations were measured by planimeter from a U.S.G.S. Quadrangle topographic map. Reservoir storage capacity included surcharge levels exceeding the top of the dam, and the spillway rating curve was based on the assumption that the dam remains intact during routing.

Drawdown calculations indicate that to empty the lake to an elevation of 569.3 NGVD through the ten low-level sluice gates and one of the two 48-inch steel pipes(the one with the 7 - 16-inch blow off valves) would take 13 hours with an inflow of 127.4 cfs, assuming 2 cfs/square mile.

b. Experience Data

Records of daily gage height and discharge have been maintained since 1898. These records were obtained from a water-stage recorder located on the left side of the dam and by records collected by the U.S.G.S. in cooperation with the Department of Public Affairs, Division of Water Supply, City of Newark.

Prior to May 22, 1970, discharge figures were furnished solely by the City of Newark. The records represent flow over the intake dam only. Water was diverted above the dam and regulated by several reservoirs above the dam prior to the completion of Charlotteburg Dam, circa 1961.

Stream flow records of the U.S.G.S. indicate that the maximum recorded discharge over the Macopin Reservoir Dam was about 6,100 cfs and occurred on October 10, 1903. The 1903 flood is the most severe one on record of the Pequannock River watershed.

c. Visual Observation

The discharge from the spillway veers right about 90 degrees, or parallel to the spillway, to a point where the dam begins. From this point the channel turns left, also about 90 degrees, flowing downstream in the median between the embankments of Route 23 Northbound and Southbound. The channel is in good condition. Some boulders, fallen trees and debris are on the bottom of the channel.

Approximately 600 feet from the spillway the channel flows under a bridge that carries traffic making U-turns from both Northbound and Southbound Route 23. The flow continues downstream and crosses under Southbound Route 23 about 3,400 feet from the spillway. The first house downstream, about 2.5 miles from the spillway, is on the channel's right bank and on the outskirts of the City of Butler.

The left side slopes of the reservoir are flat to moderate. A concrete crib wall is on the right side of the reservoir (the Route 23 Southbound embankment side). The crib wall is in good condition. Both the side slopes and crib wall do not exhibit signs of instability. The drainage area is mostly wooded and moderately flat sloped.

d. Overtopping Potential

As indicated in Section 5.1a, the spillway capacity of Macopin Reservoir Dam is considered to be adequate for 1/2 PMF (SDF).

# SECTION 6

## 6. STRUCTURAL STABILITY

### 6.1 Evaluation of Structural Stability

#### a. Visual Observations

At the time of inspection Macopin Reservoir Dam did not exhibit any visible signs of distress. There was no evidence of tilting, misalignment or movement on the foundation. There were five stones missing in the downstream side of the stone masonry spillway and there were some areas between the stones that need re-grouting. There were some longitudinal cracks and spalling in the concrete coping of the spillway and the high dam.

Based on a visual inspection, and in view of more than 88 years of satisfactory past perfomance, the structure appears to be stable, but based on the results of the preliminary static stability analyses performed the dam's stability is in question.

#### b. Design and Construction Data

No design computations relating to stability were uncovered during the report preparation phase. The plans do show typical sections of the high dam and spillway (the spillway is also called the overfall on the Plans).

The high dam has a five foot cutoff to a depth of approximately elevation 546. Whether this cutoff has the structural capacity to act as a key is not known. The spillway's base elevation is somewhat vague. The plans indicate that the spillway's base is founded at elevation 563.7 meaning that the spillway has no footing or cutoff. A typical foundation profile, Plate 6, does not classify the foundation material, but the presence of a cutoff would indicate earth or rock fill for the high dam and rock for the spillway.

#### c. Operating Records

No operating records are available relating to the stability of the dam.

#### d. Post Construction Changes

Construction Plans, dated 1940, show procedures for guniting the upstream face of the dam.

#### e. Static Stability

Preliminary static stability analyses were performed for Macopin Reservoir Dam for the high dam and the spillway. The results and assumptions made are shown in Appendix E.

The calculations herein do not show instability against overturning or sliding under maximum flood conditions. However, the location of the resultant force and the sliding Factors of Safety do not meet current standards particularly under full uplift conditions. It's apparent that full uplift pressures were not considered in the design of the dam. Assuming full uplift pressure under the high dam is perhaps too conservative because the head water pressure at the heel is reduced in passing through the 15 feet of upstream earth and rock fill above the heel. This rationale is not valid for the spillway unless there is extensive silting at the heel that would reduce the head water pressure. The reduction in head water pressure would be due to the thickness of silt creating a longer drainage path and dissipating the differential pressure between the head and tailwater.

The maximum pool elevation at 588.14 is only 0.7 ft. higher than the 1903 flood. In view of past perfomance, especially in 1903 along with no current indications of distress, the dam is stable. To put the computed resultant forces and the sliding Factors of Safety in proper prospective, static stability analyses were also performed at the 1903 flood level. These are also included in Appendix E. When the information requested under the recommendations 1 through 3 in Section 7 is made available a realistic structural stability analysis would be made.

f. Seismic Stability

The dam is located in Seismic Zone 1, as defined in Recommended Guidelines for Safety Inspection of Dams, prepared by the Corps of Engineers. In general, projects located in Seismic Zones 0, 1 and 2 may be assumed to present no hazard from earthquake, provided the static stability conditions are satisfactory and conventional safety margins exist.

Preliminary static stability calculations show that the resultant force and the sliding Factors of Safety do not meet current standards. Obviously, since static stability calculations do not meet standards, seismic stability-a greater stress condition, would also be unsatisfactory.

# SECTION 7

## 7. ASSESSMENT/REMEDIAL MEASURES

### 7.1 Dam Assessment

#### a. Safety

The dam has been inspected visually and a review has been made of the available engineering data. This assessment is subject to the limitations inherent in the visual inspection procedures stipulated by the Corps of Engineers for a Phase I report.

The Macopin Reservoir Dam is considered adequate because the dam does have adequate spillway capacity to pass the 1/2 PMF which is the SDF for the dam, without overtopping.

The dam's stability is in question since it apparently was designed without considering uplift forces on the base plane. A preliminary evaluation of the stability of the dam shows that it would have difficulty in meeting current Corps of Engineers' stability guidelines at maximum pool elevation. However, the dam has safely passed the 1903 flood, which was only 0.7 feet lower than the computed maximum pool elevation.

#### b. Adequacy of Information

The information uncovered was adequate to perform hydrologic and hydraulic computations. The data was sufficient to perform an approximate computation of the stability of the dam. A preliminary assessment of the dam could be made by visual observation only.

#### c. Urgency

The remedial measures and recommended actions along with a timetable for their completion are detailed below. All recommended action should be conducted under the supervision of an engineer who is experienced in the design, construction and inspection of dams.

## 7.2 Remedial Measures

### a. Alternatives for Increasing Spillway Capacity

ALternatives for increasing spillway capacity are not necessary as it is adequate to handle the SDF.

### b. Recommendations

1. Acquire foundation data by a boring program to determine the spillway and high dam foundations and determine the dam's masonry, earth and rock engineering properties within twelve months.

2. Determine the uplift pressures by piezometers at various points along the base of the dam including points along the heel and toe of the dam within twelve months.

3. Determine the silt levels adjacent to the dam's heel within twelve months.

4. Replace the missing stones and re-grout those areas that have grout missing in the downstream side of the spillway within twelve months.

5. Repair all cracked and spalled concrete in the top of the spillway and the high dam within twelve months.

6. Repair or replace the defective low-level outlet blow-off valve within twelve months.

7. All debris should be removed from the spillway discharge channel within twelve months.

8. The existing dam plans and drawings should be annotated and updated to form a coherent as-built set within twenty-four months.

The following additional action is recommended:

> The owner should develop an emergency action plan (if one is not already available) outlining actions to be taken by the operator to minimize downstream effects of an emergency and establish a flood warning system for the downstream communities within three months.

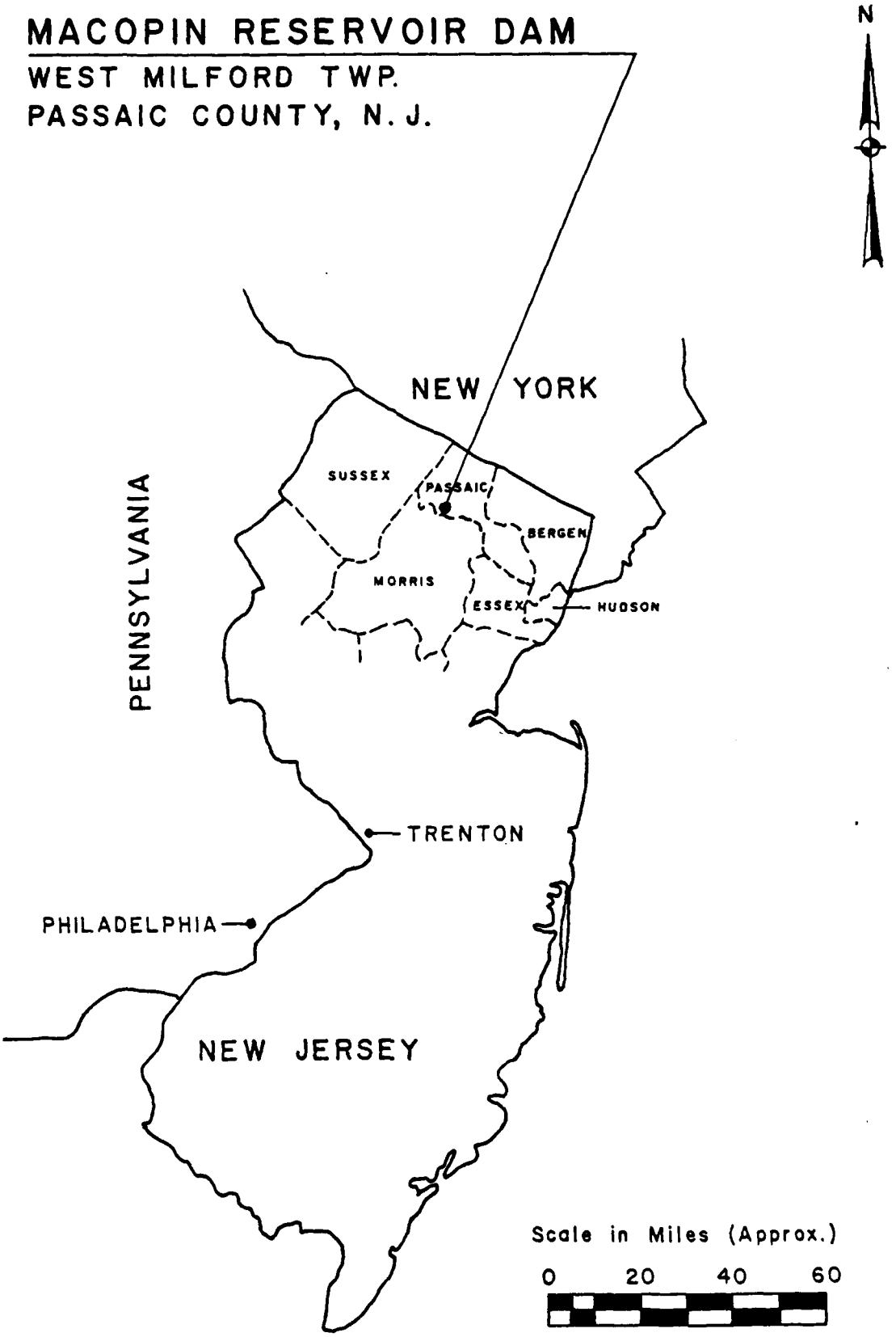
c. O & M Procedures

The owner should develop, within one (1) year after formal approval of the report, written operating procedures and a periodic maintenance plan to insure the safety of the dam.

PLATES

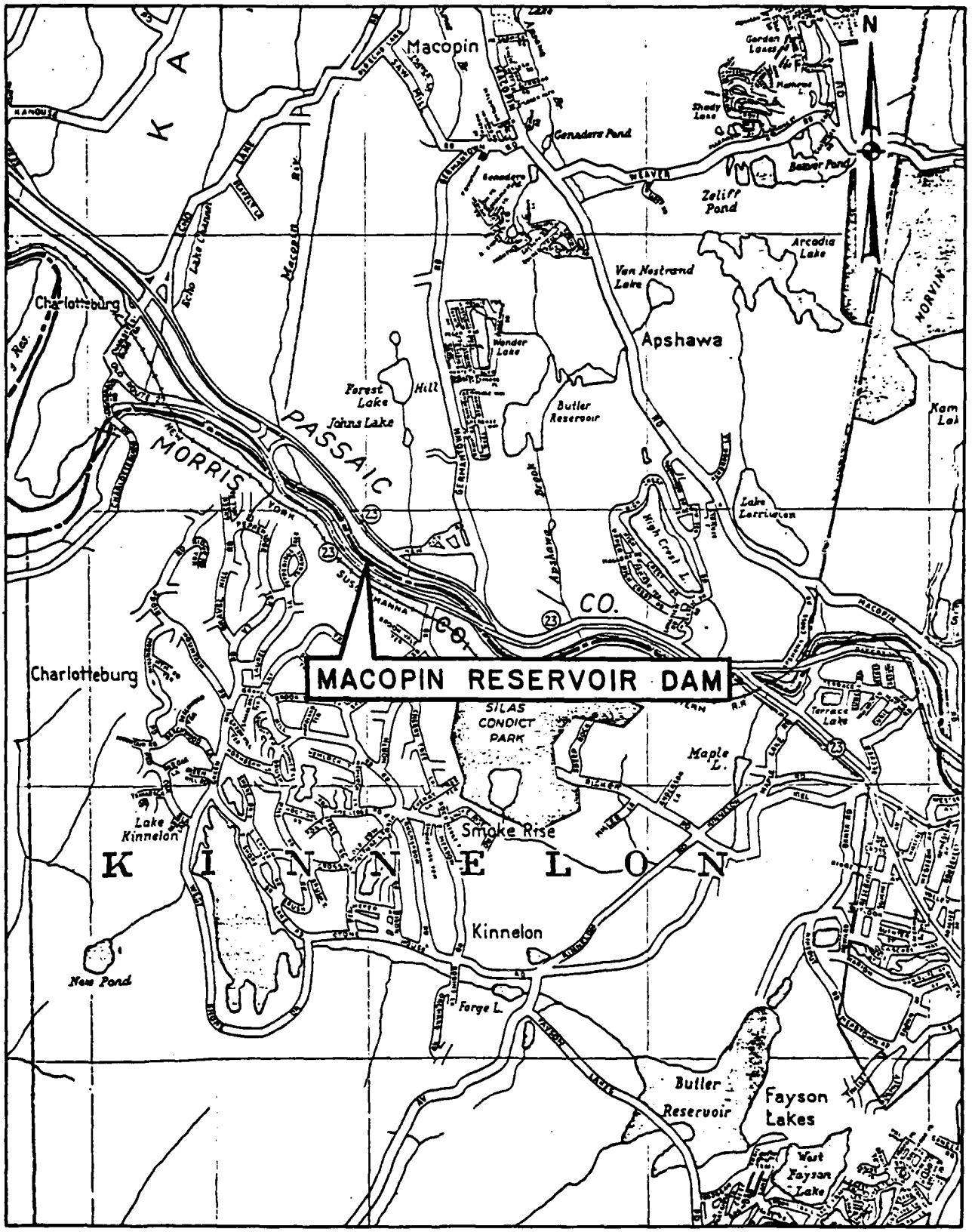
# MACOPIN RESERVOIR DAM

WEST MILFORD TWP.
PASSAIC COUNTY, N. J.




KEY MAP

PLATE 1

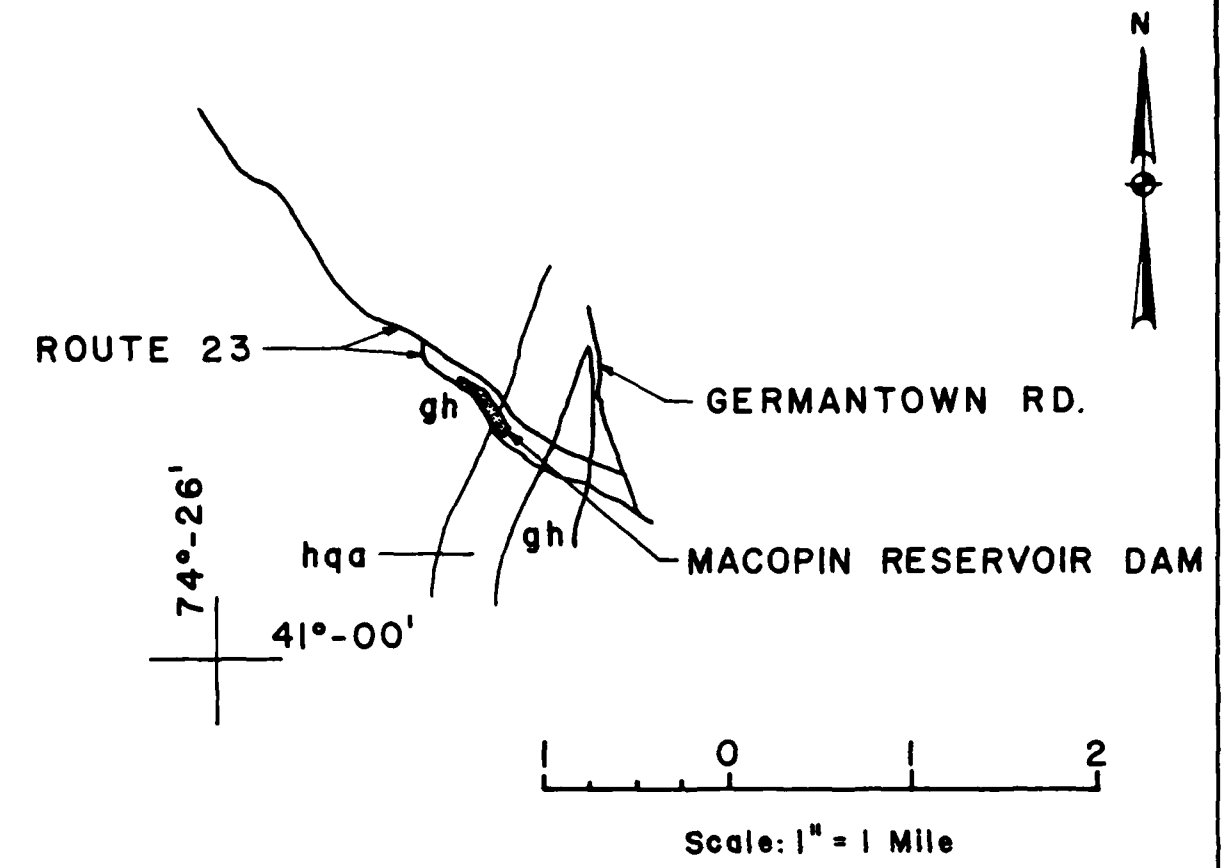



Scale in Feet (Approx.)

2,000 0 2,000 4,000 6,000 8,000 10,000

# VICINITY MAP

PLATE IA



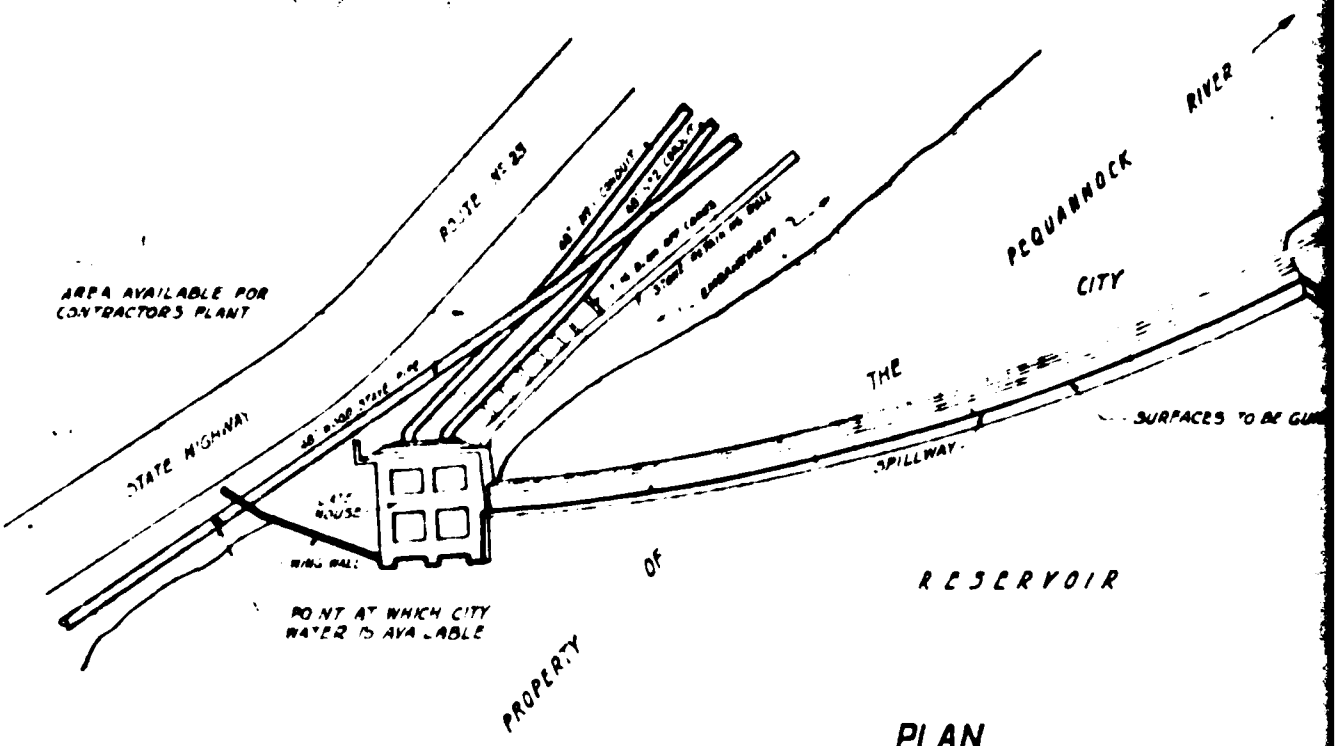

LEGEND:

PRECAMBRIAN

| | |
|---|---|
| gh | Mostly Hornblende Granite and Gneiss. |
| hqa | Hyperstene-Quartz-Andesine-Gneiss. |

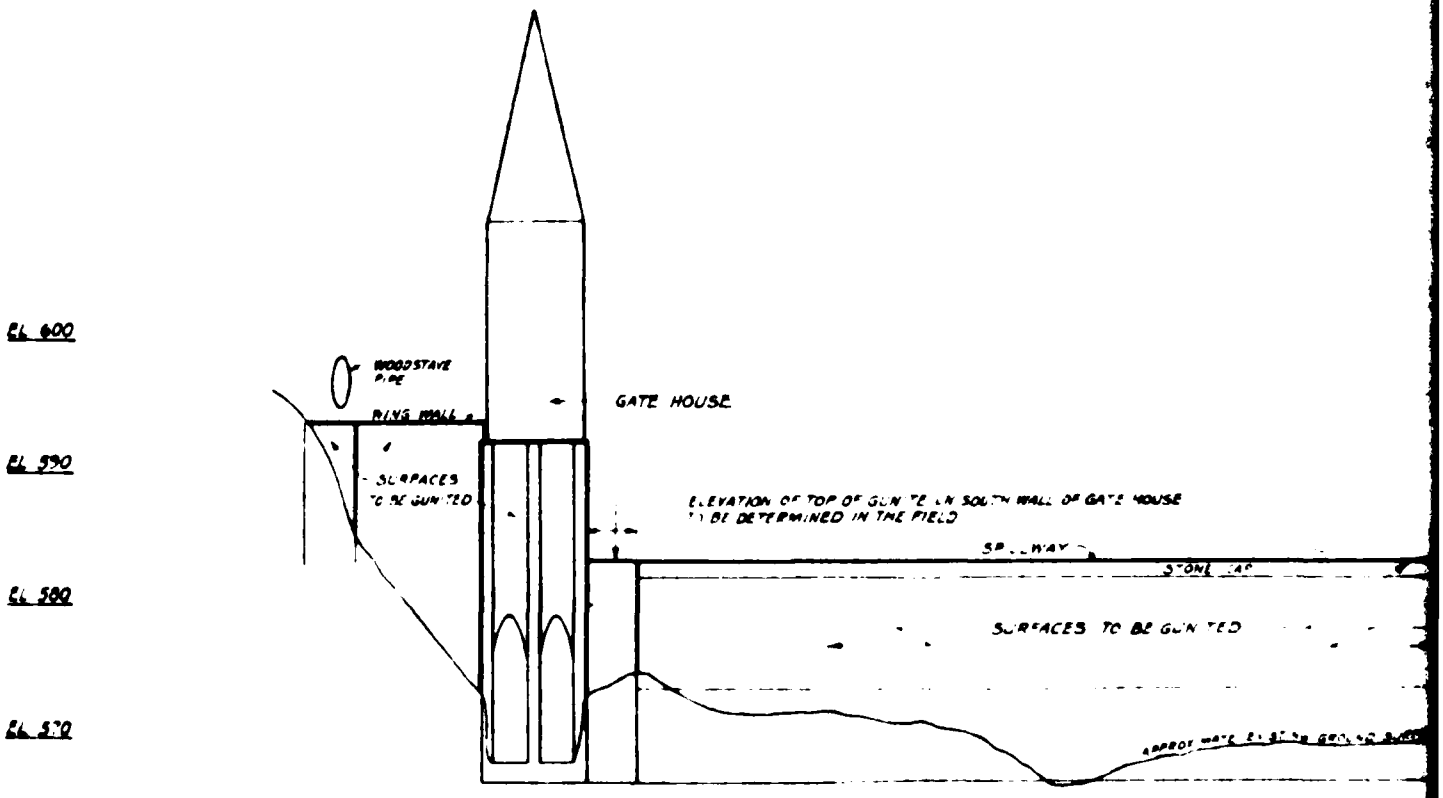
# GEOLOGIC MAP
# MACOPIN RESERVOIR DAM

PLATE 2



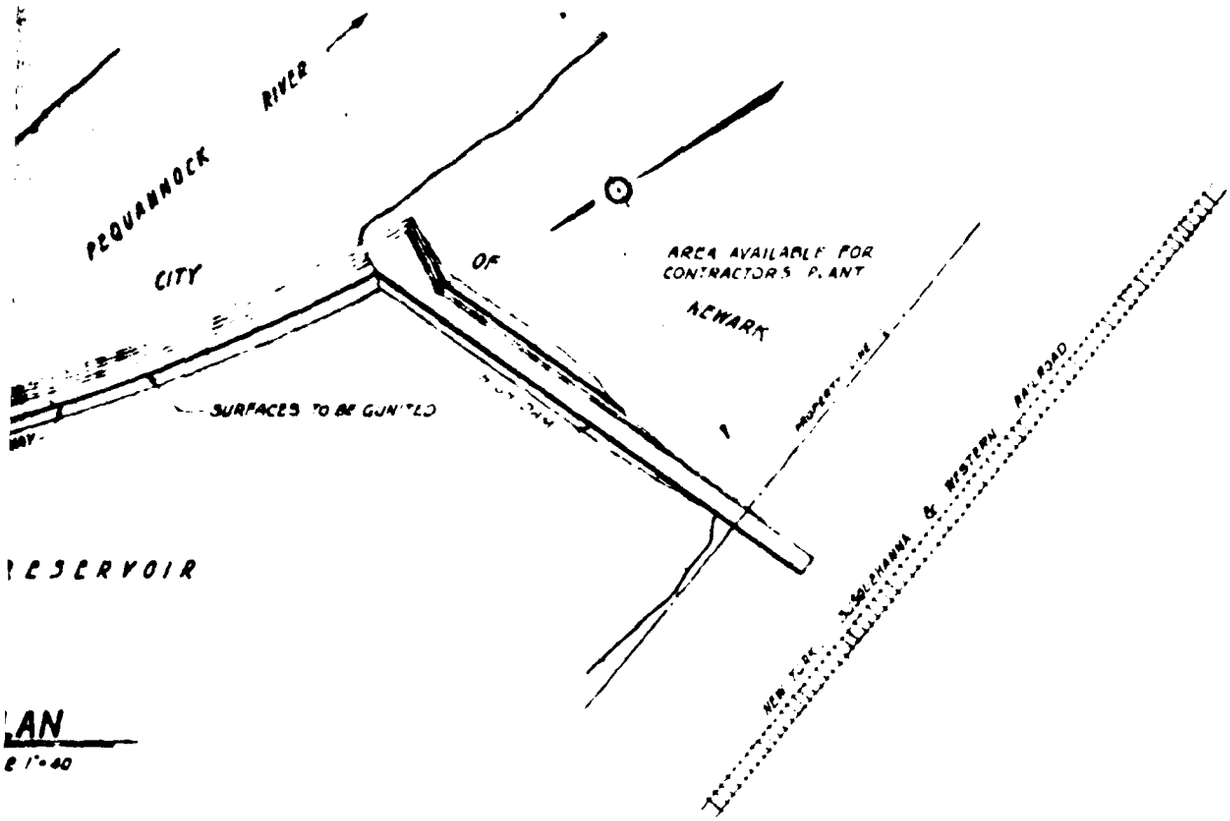

## PLAN

SCALE 1" = 40'




## PROFILE

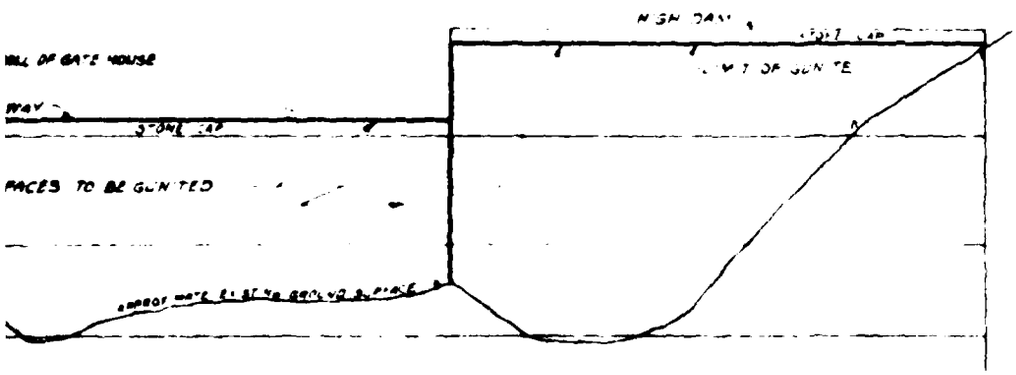
SCALES: HOR. 1" = 40'




RESERVOIR

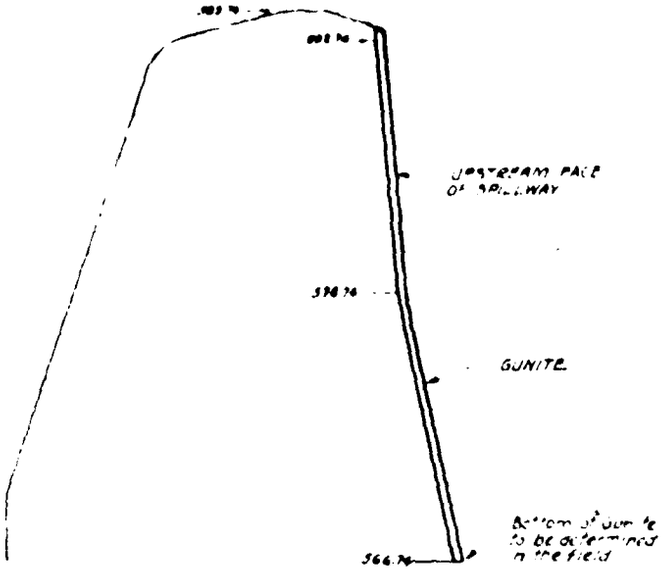
PLAN
SCALE 1"=40

SPILL
SCALE



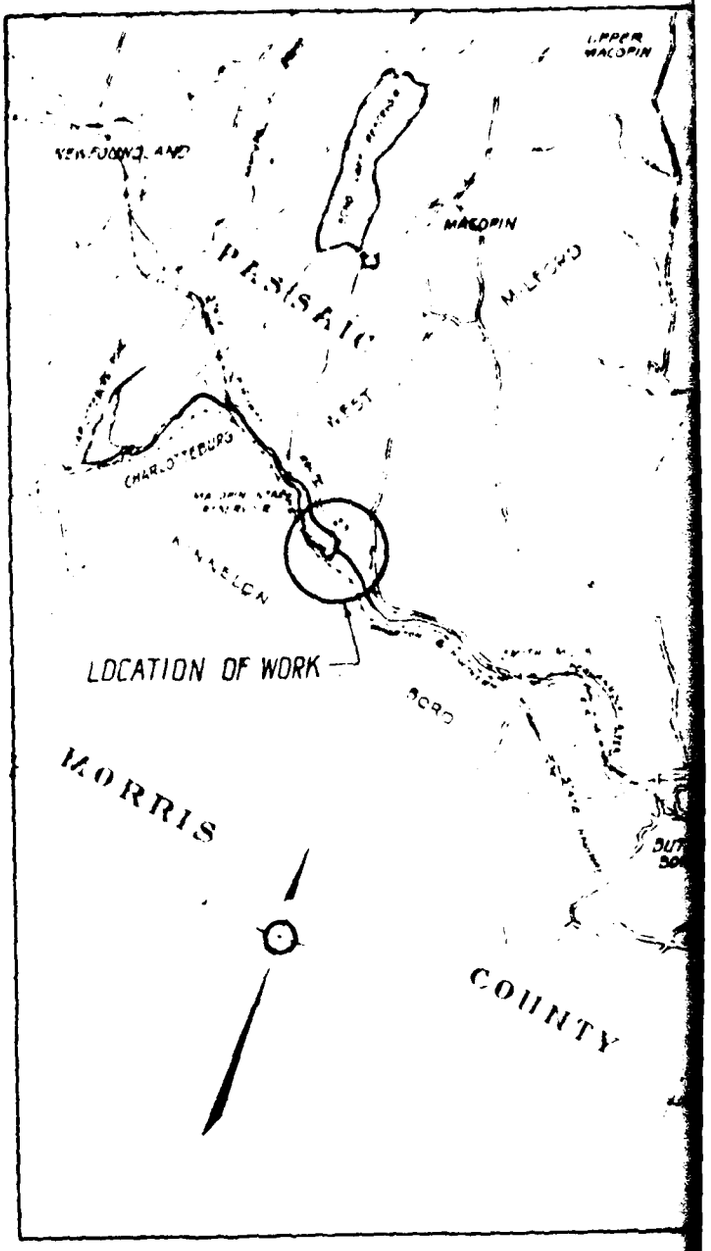

PROFILE

3



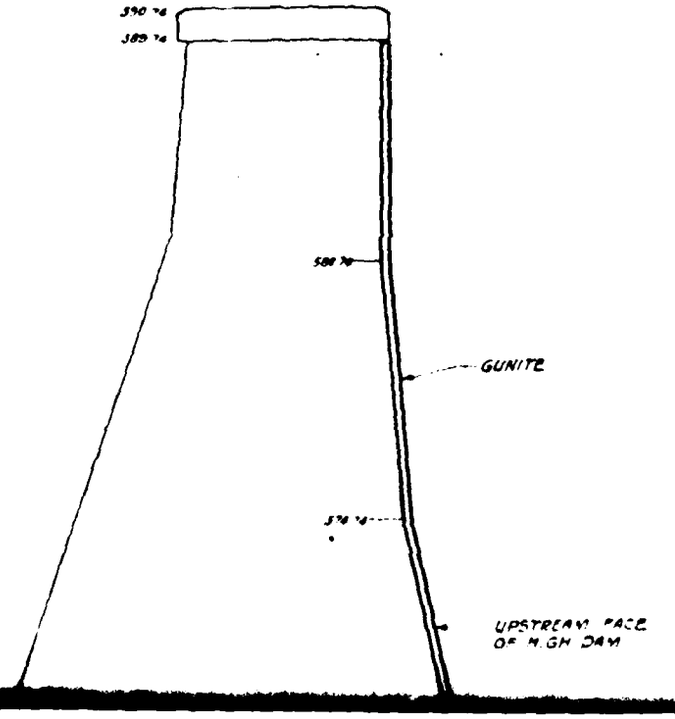

SPILLWAY

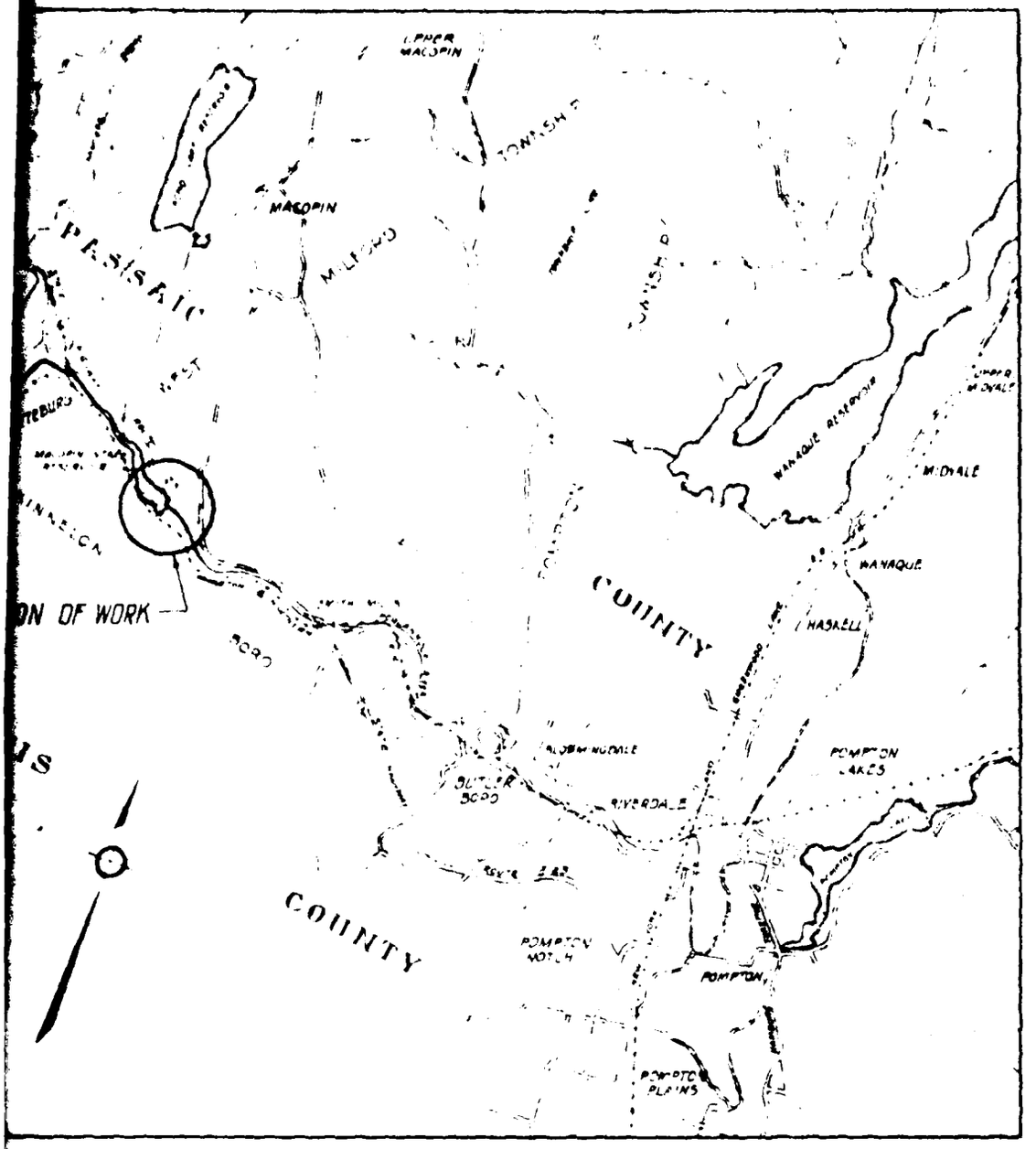
SCALE 1/8" = 1'-0"




LOCATION

SCALE 1" = 1






## LOCATION PLAN

SCALE 1" = 1 MILE

EL 590

EL 580

EL 570

EL 560

SURFACES TO BE GUNITED

ELEVATION OF TOP OF GUNITE ON SOUTH WALL OF GATE HOUSE TO BE DETERMINED IN THE FIELD

SPILLWAY

STONE CAP

SURFACES TO BE GUNITED

APPROXIMATE EXIST

## PROFILE

SCALES: HOR. 1" = 40'
VERT. 1" = 10'

STONE CAP

2-½" ϕ BAR

¼" EXPANSION BOLTS 4" LONG @ 24" O.C. BOTH WAYS.

UPSTREAM FACE OF SPILLWAY

1"

4"x4" NO 6 STEEL WIRE MESH

1'-2" MIN

EXIST NO STONE MASONRY

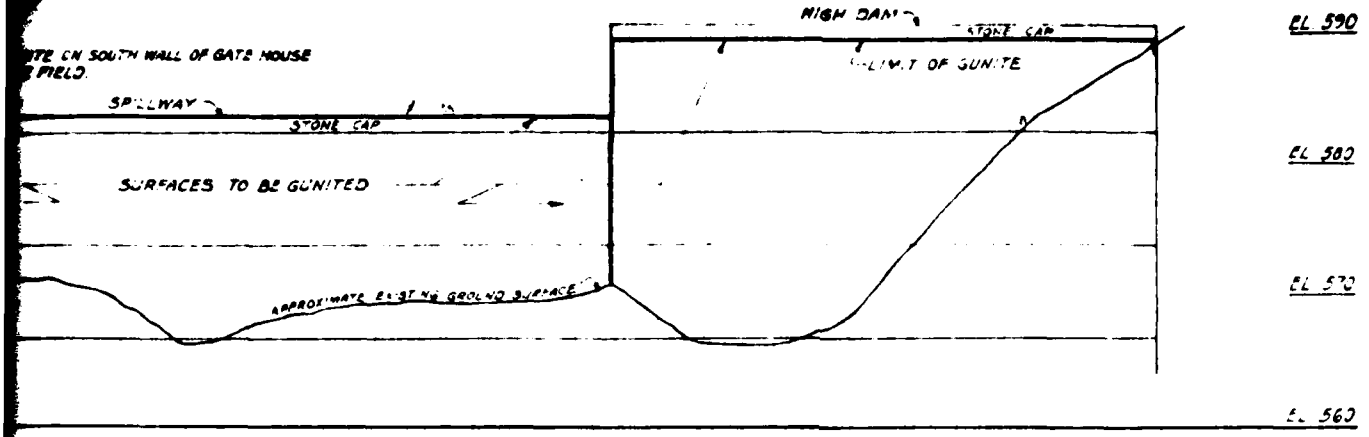
GUNITE

¼" MIN

## DETAIL OF SPILLWAY

SCALE 3"=1'-0"

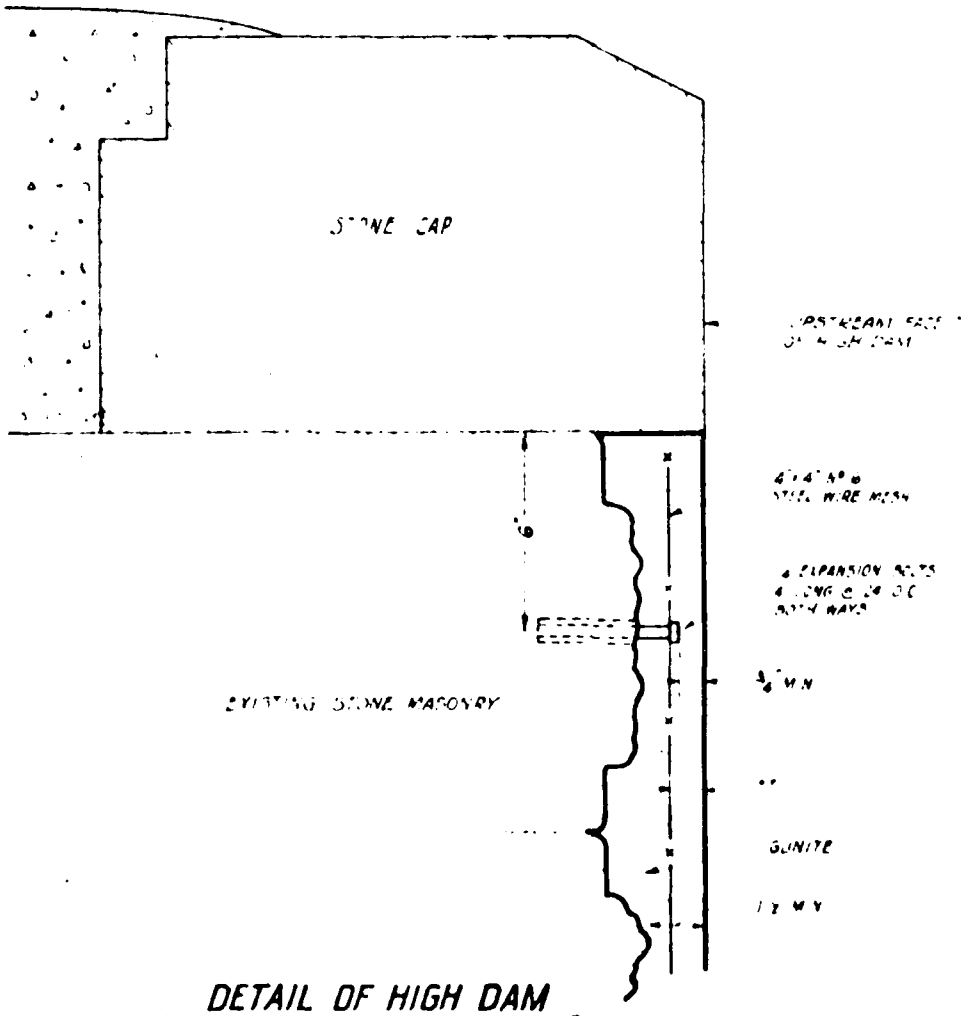
DRAWN BY E T E
TRACED BY R B T




## PROFILE

SCALES: HOR. 1" = 40'
VERT. 1" = 10'

6




## DETAIL OF HIGH DAM

SCALE 3" = 0"

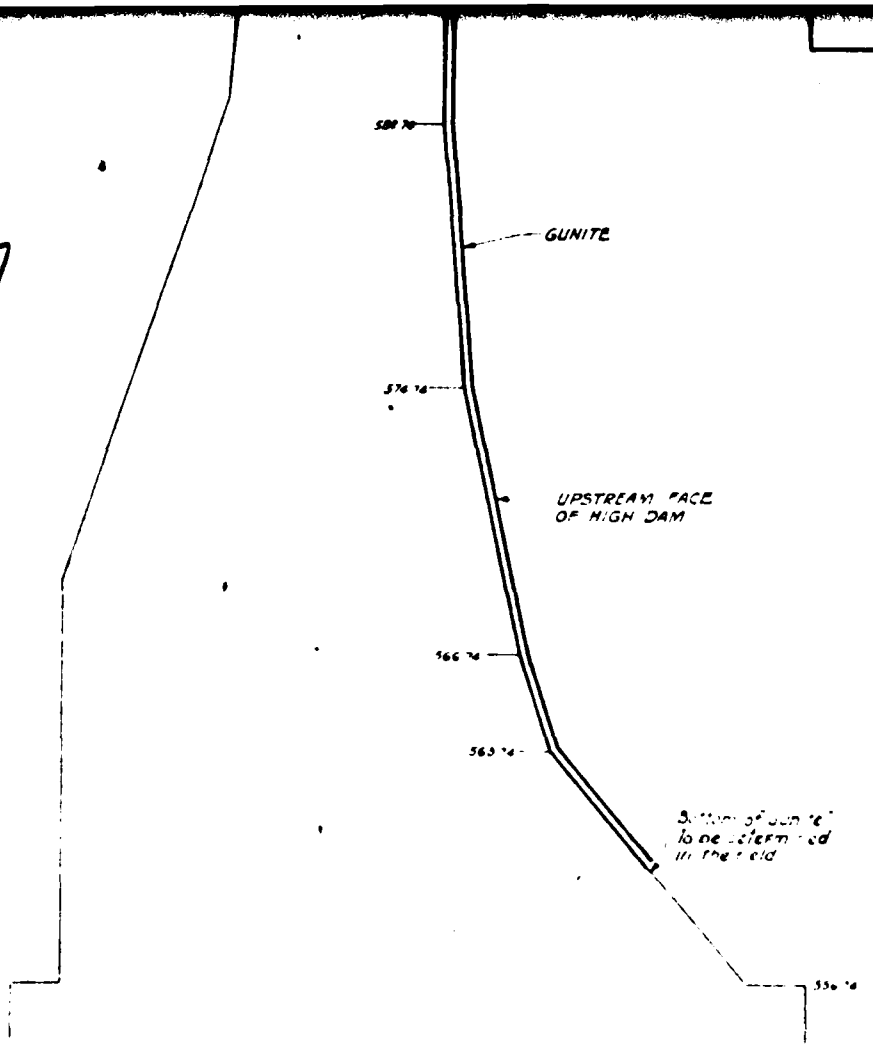
EL 590

EL 580

EL 570

EL 560

7




HIGH DAM

SCALE 1/4" = 1'-0"

## LOCATION PLAN

SCALE 1" = 1 MILE

8

FACE
DAM

RECEIVED
NOV 14 1979
HARRIS, HILL
WOODBRIDGE, N. J.

# CONTRACT NO. 44

# GUNITING THE UPSTREAM FACE OF MACOPIN DAM

SCALES AS SHOWN

| DATE | APPROVALS |
|---|---|
| | |
| | |
| | |

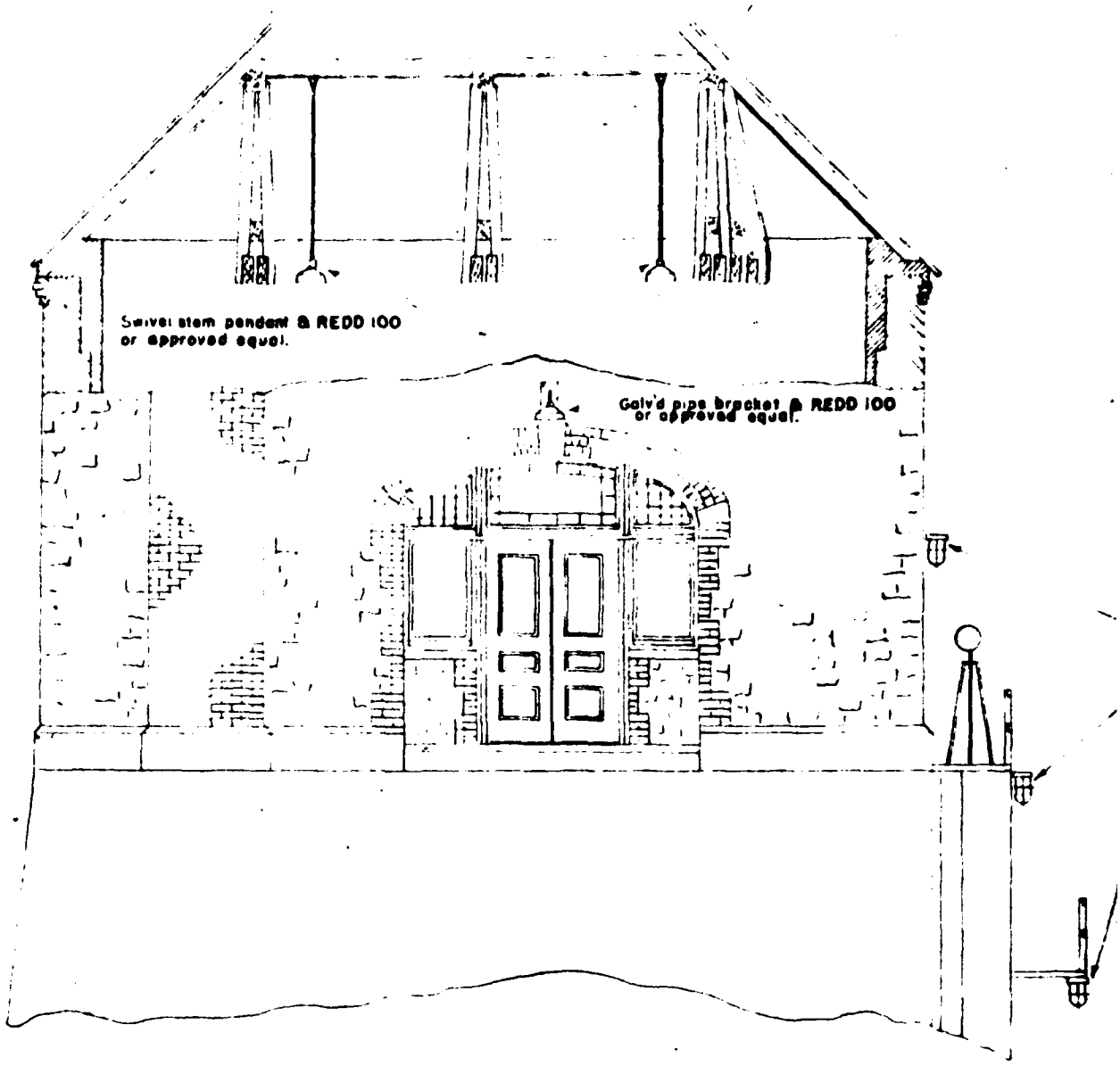
DEPARTMENT OF PUBLIC AFFAIRS
DIVISION OF WATER
NEWARK, N. J.

SHEET 1 OF 1

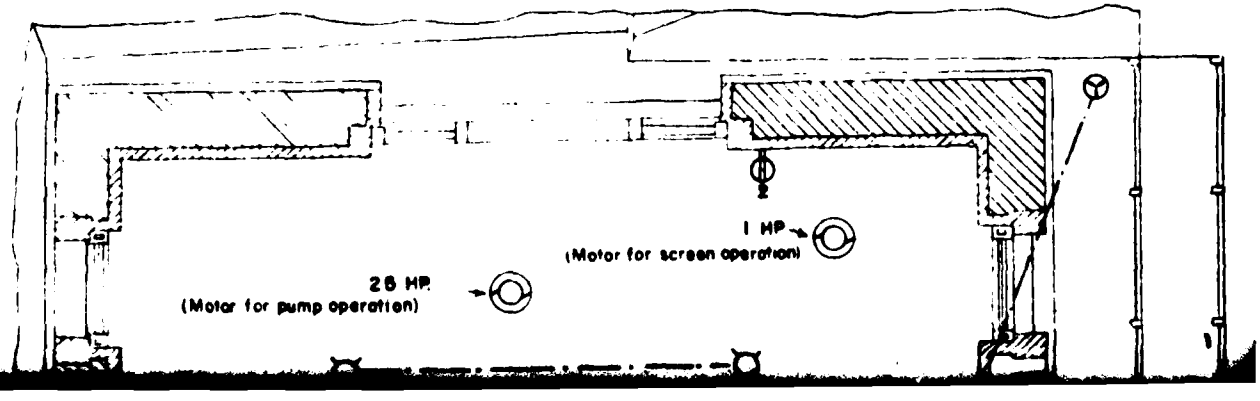
| CASE | PKT | FLDR | FILE | ACC. |
|---|---|---|---|---|
| 2 | 8 | 1 | 3.3M | 2701 |

PLATE 3

6 - 3




BROKEN NORTH ELEVATION AND SECTION A-A.



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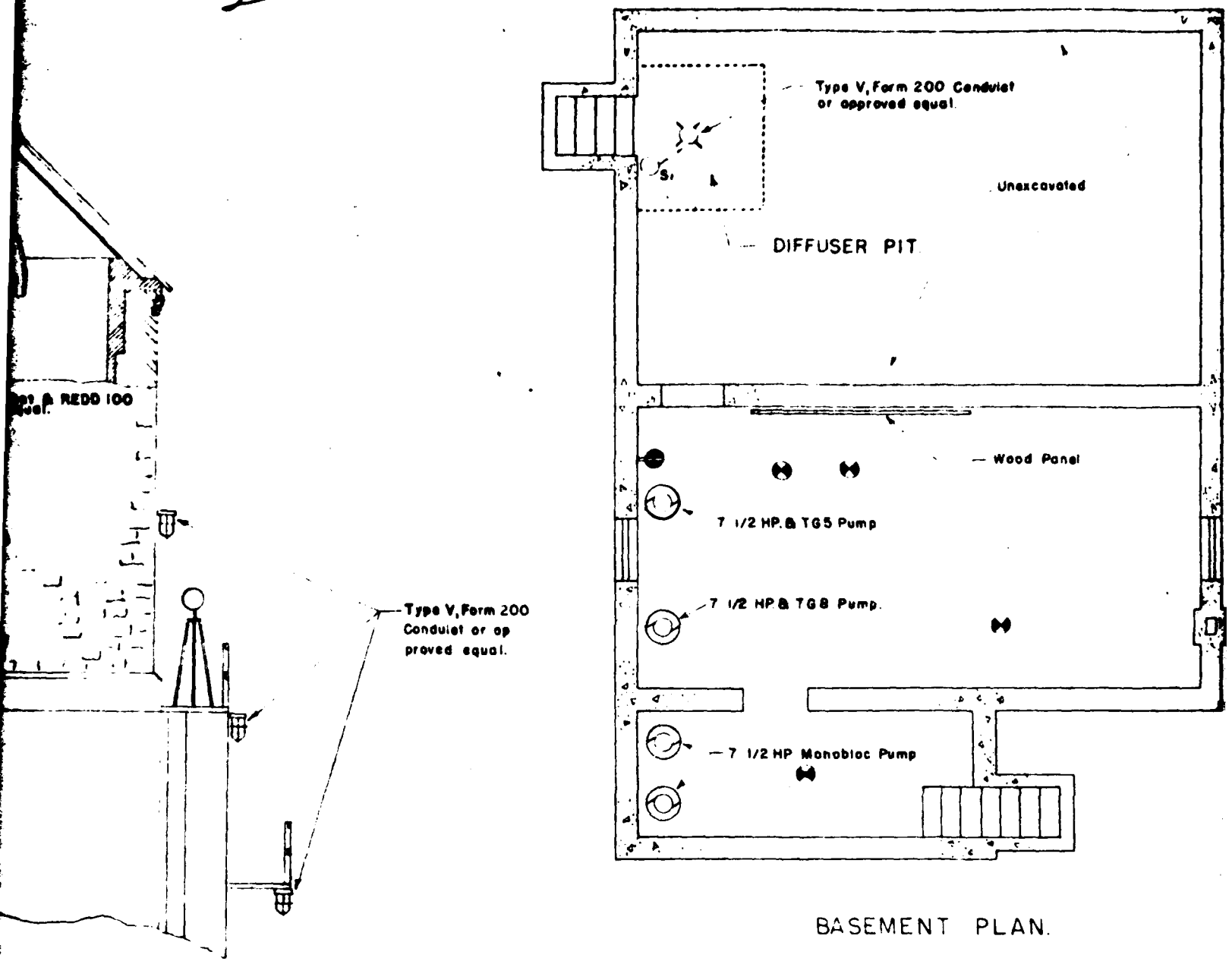
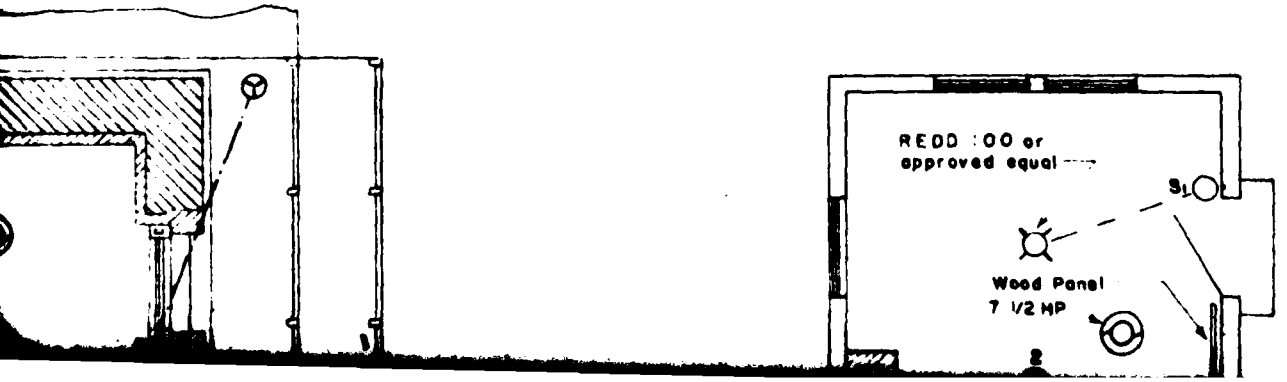


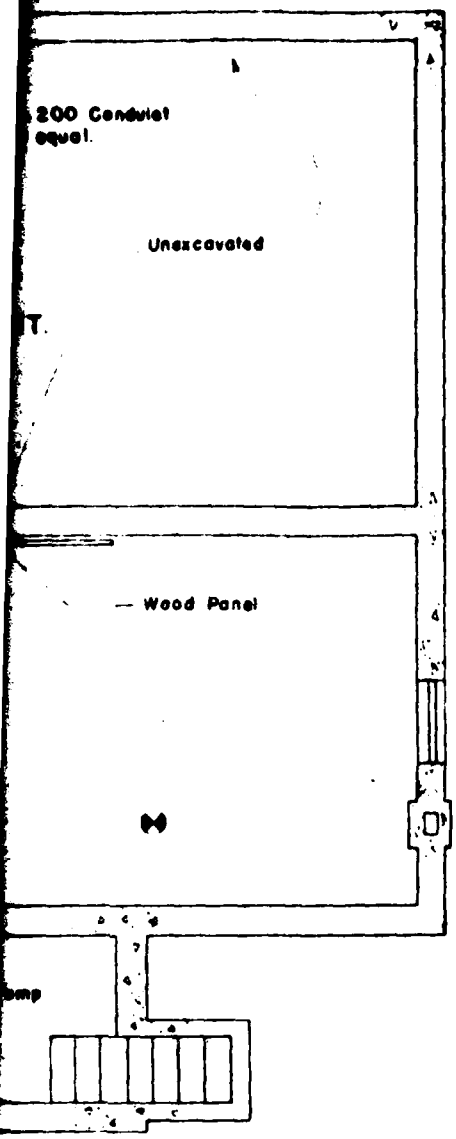

BASEMENT PLAN.

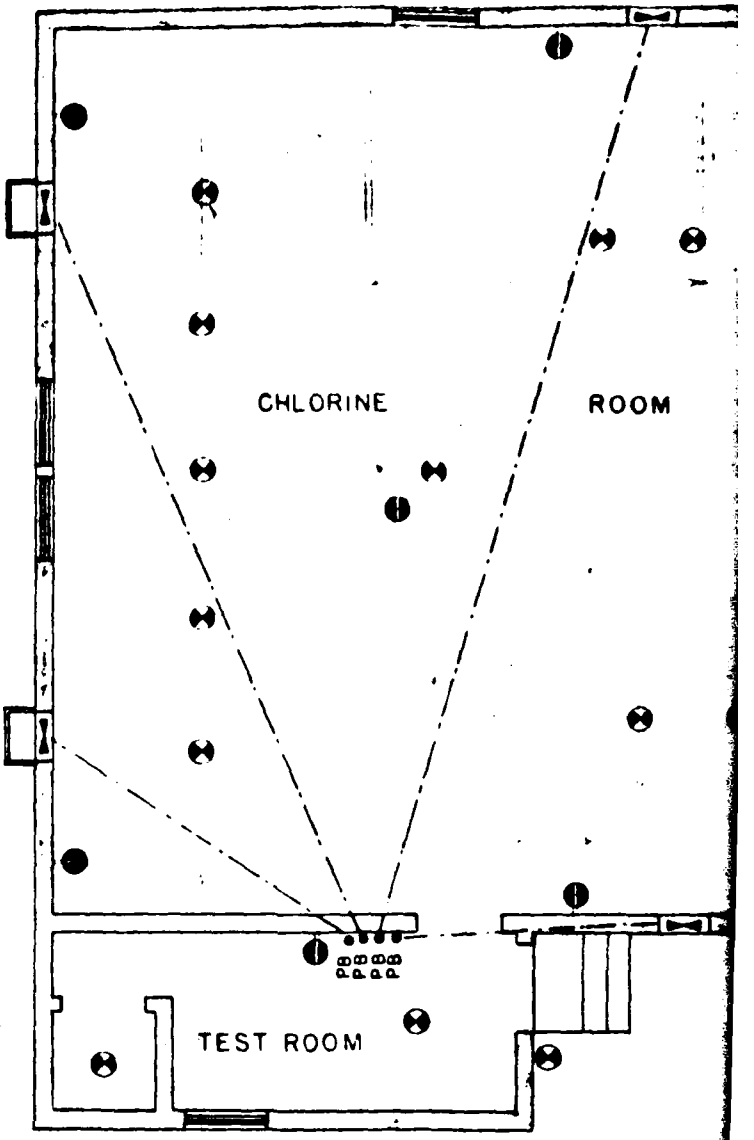
N A-A.

WATI



3

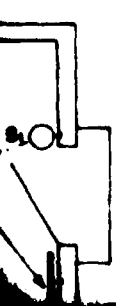


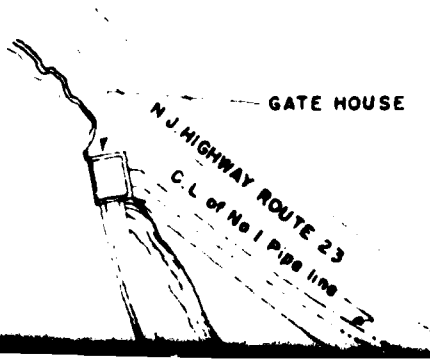




MENT PLAN.

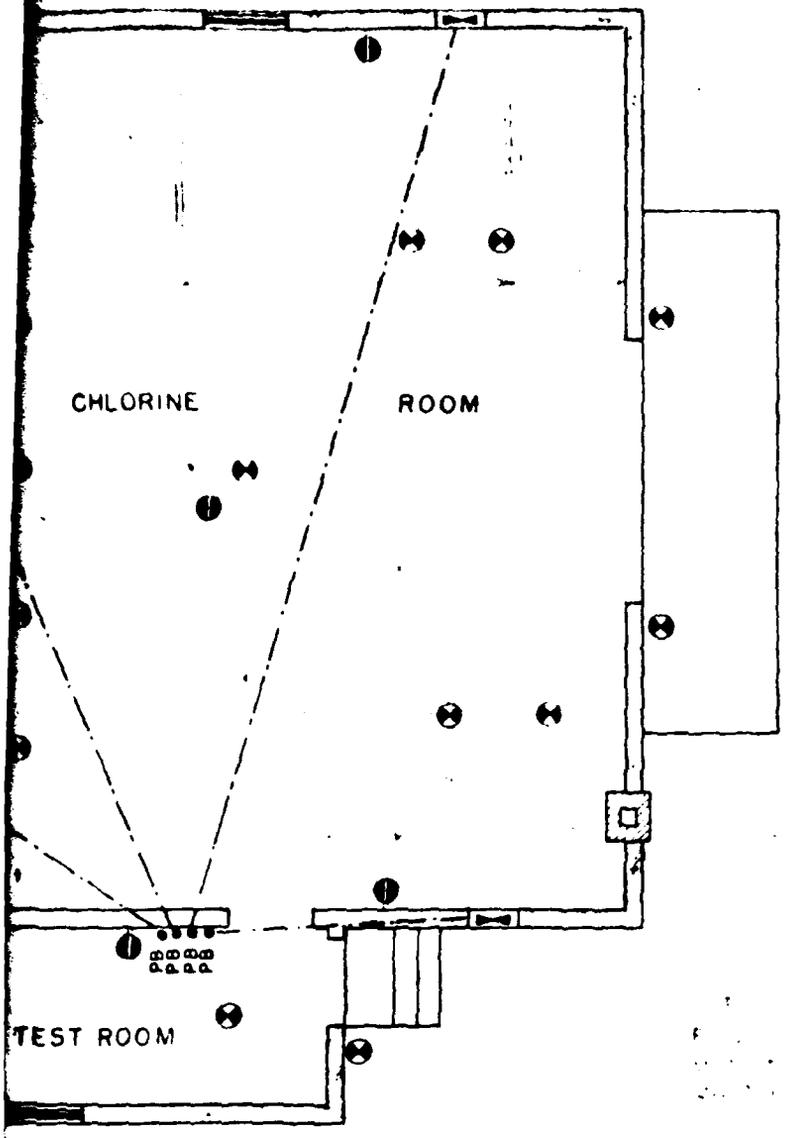
FLOOR PLAN.

# WATER TREATMENT PLANT.






4




FLOOR PLAN.

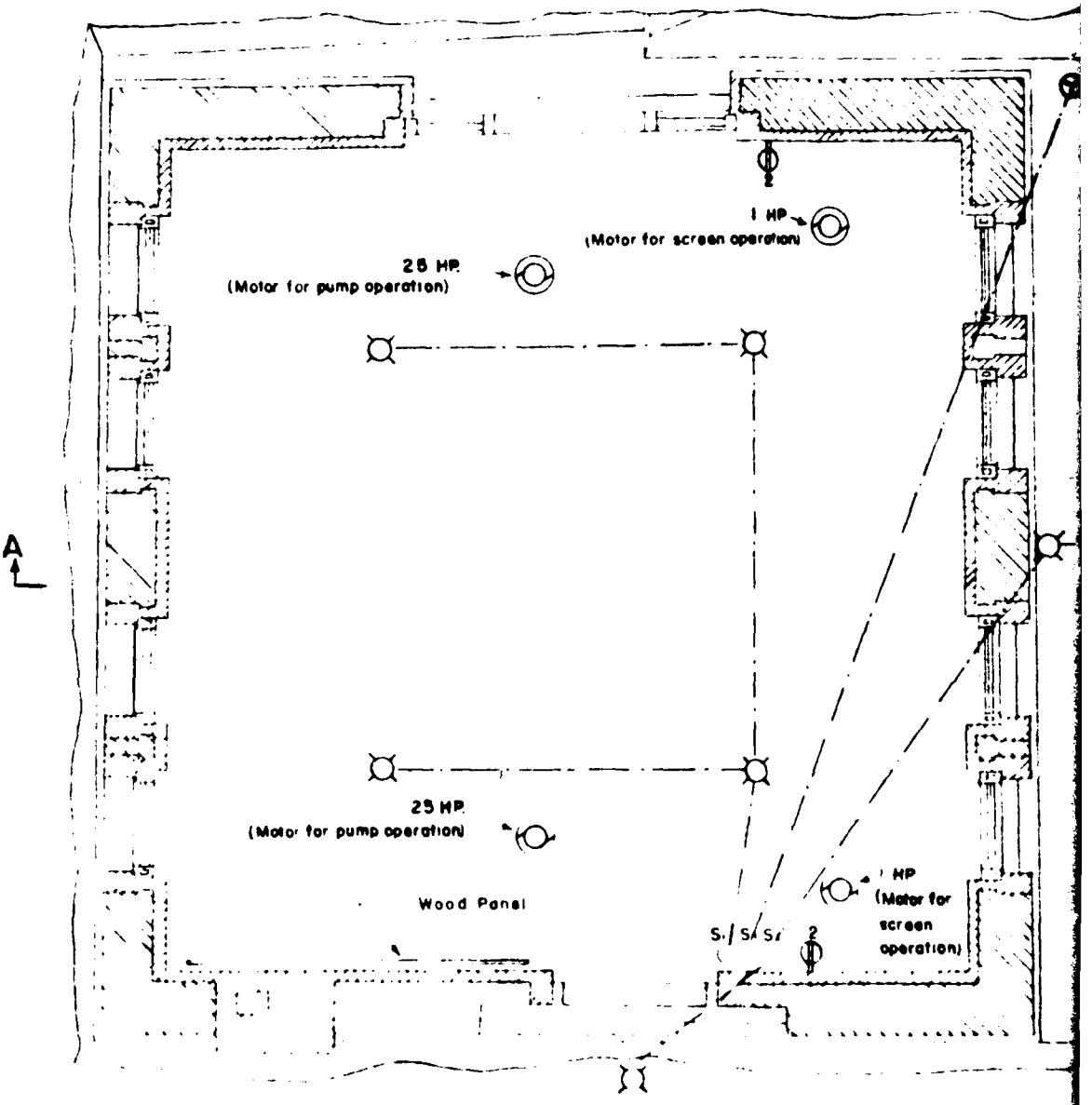
Reservoir.

1300'±

--WATER TREATMENT PLANT

BROKEN NORTH ELEVATION AND SECTION A-A.

5



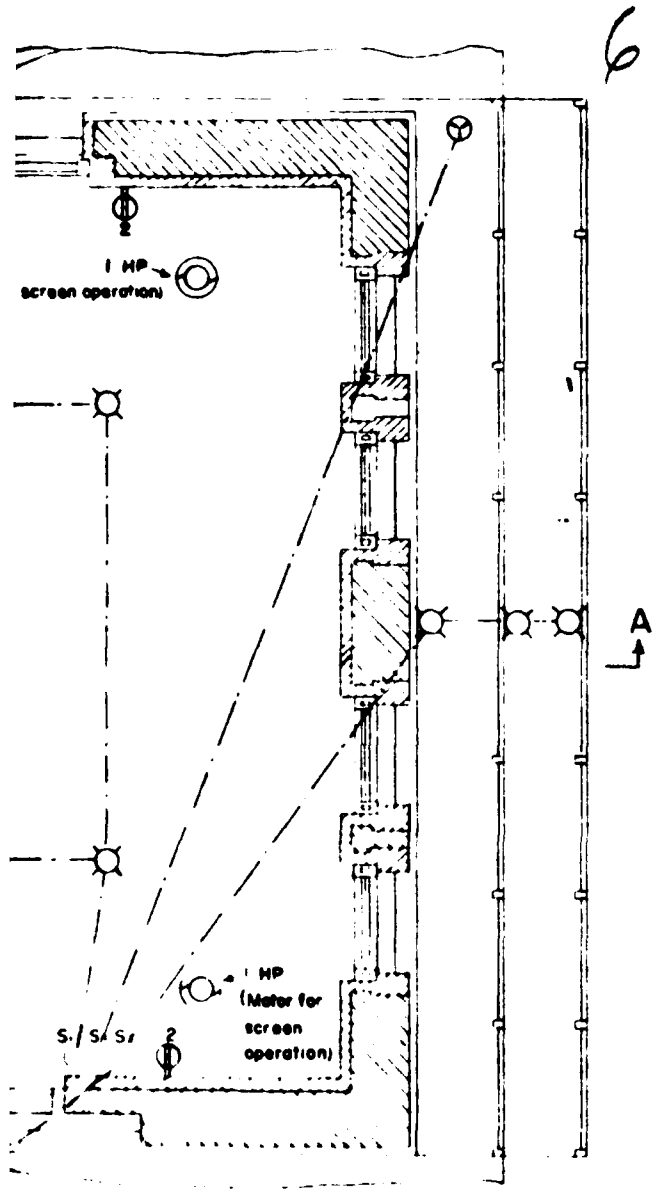

PLAN

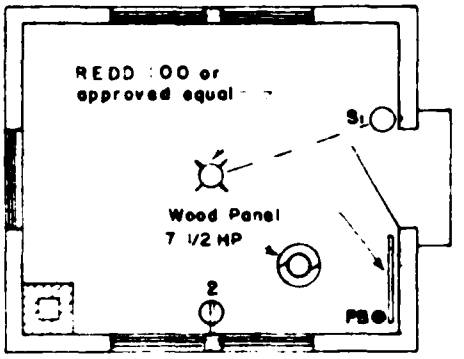
MACOPIN GATE HOUSE.

C PWOODNUTT
ASST ENG'R

BASEMENT PLAN.

ID SECTION A-A.




TEST HOUSE.

LEGEND

| | |
|---|---|
| | Existing Lighting Outlet - to be retained |
| | Existing Convenience Outlet - to be retained |
| | Lighting Outlet - to be installed |
| 2 | Duplex Convenience Outlet to be installed |
| | Existing Flood Light to be retained. |
| S1 | Single pole switch - to be installed. |
| | Motor. |
| | Ventilating Fan to be installed. |
| PB | Push Button Station to be installed |

N

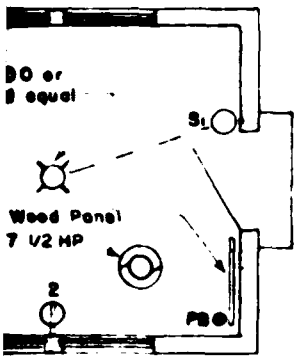
GATE HOUSE.

BASEMENT PLAN.

FLOOR PL

# WATER TREATMENT PLANT.

7




T HOUSE.

)

Inlet to be retained

Be Outlet to be retained

be installed

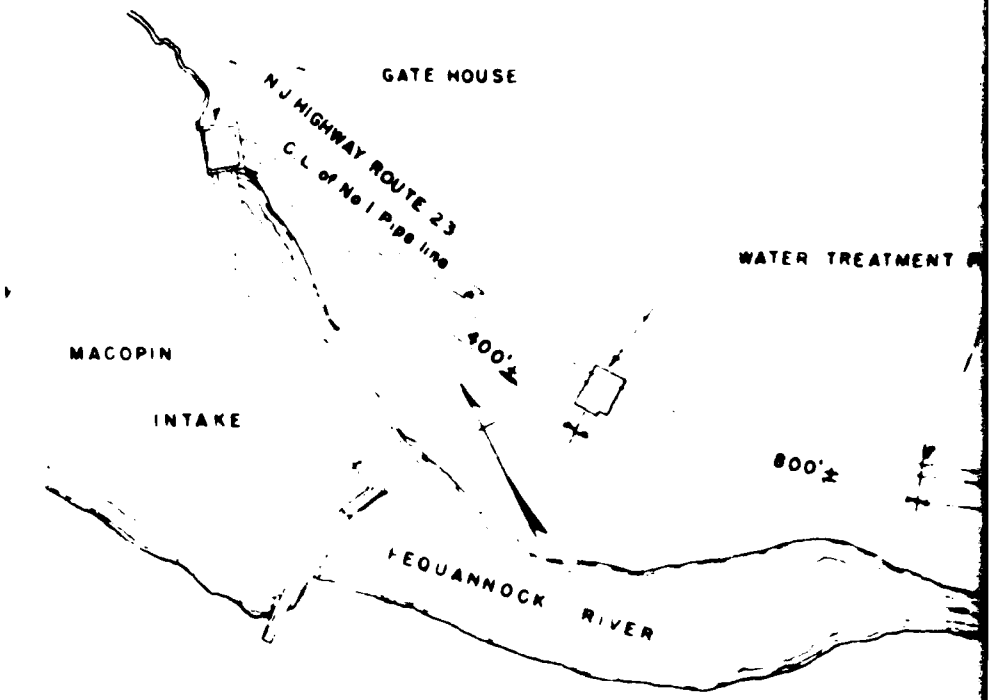
) Outlet to be installed

P to be retained.

to be installed.

be installed.

n to be installed




LOCATION PLAN

Not to scale

DATE

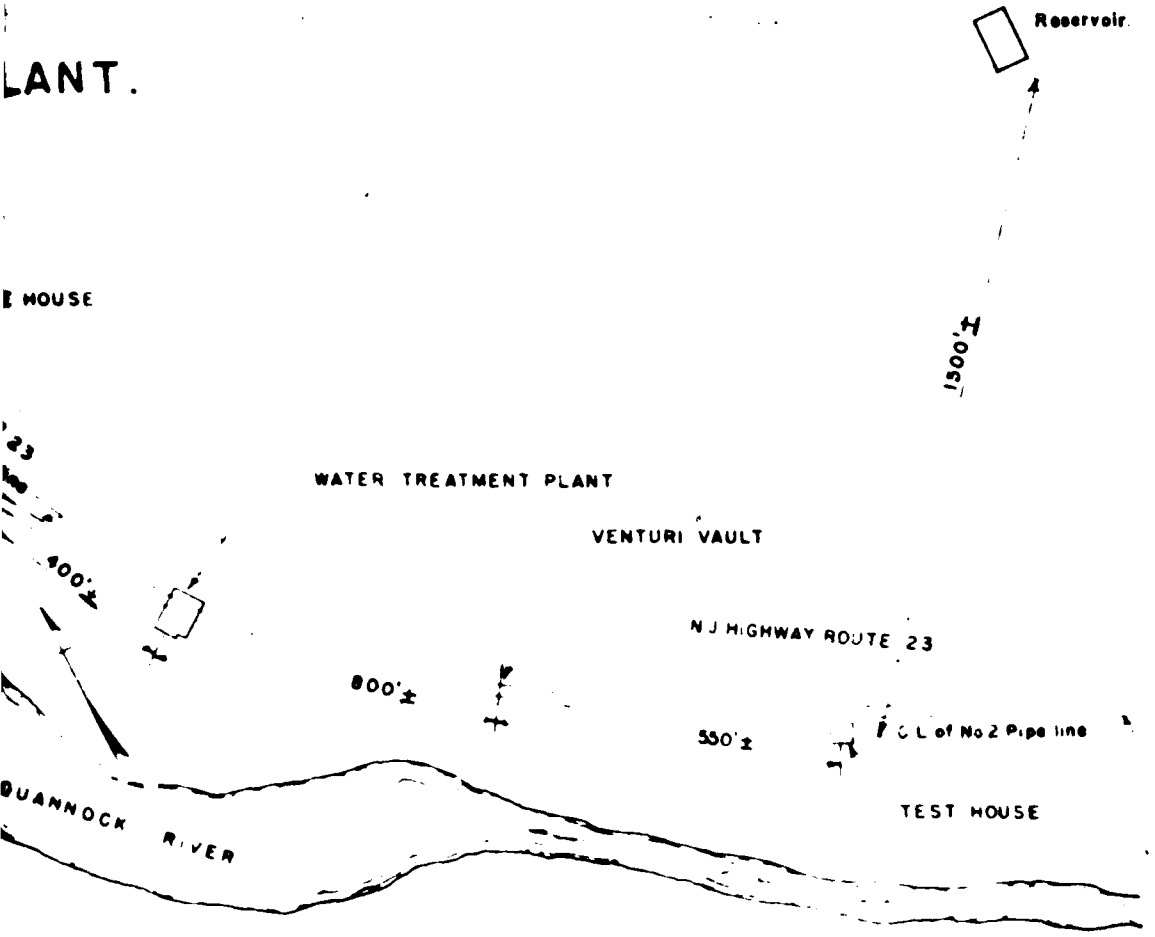
2/61 ma

5/17/

FLOOR PLAN.

LANT.

E HOUSE




LOCATION PLAN.
Not to scale

RECEIVED
NOV 14 1979
HARRIS, INC.
WOODBRIDGE, N. J.

CONTRACT NO. 68.

ELECTRICAL EQUIPMENT
IN THE MACOPIN GATE HOUSE
AND WATER TREATMENT PLANT.

SCALE 1/4" = 1'

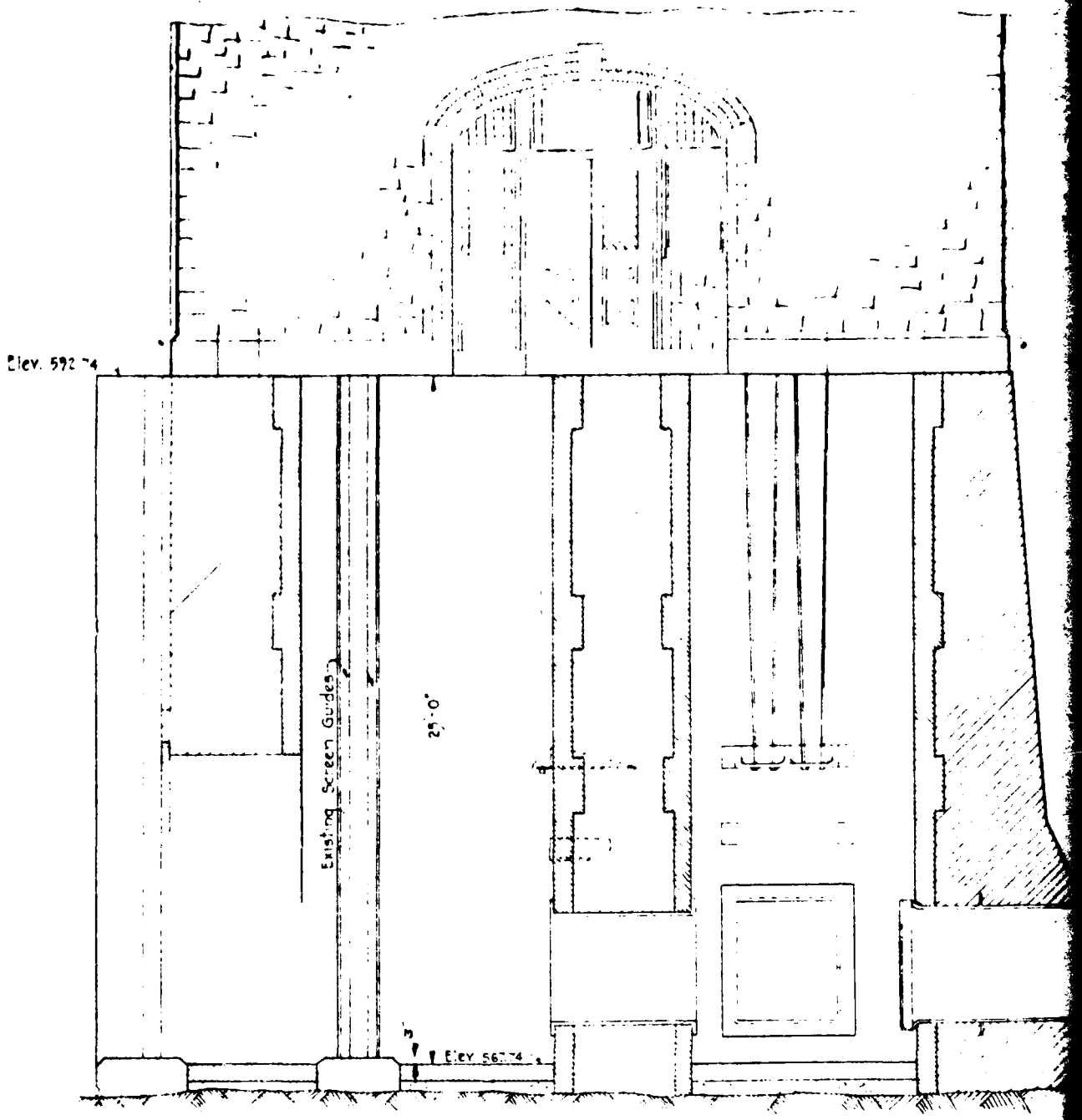
| DATE | APPROVAL |
|---|---|
| 2/6/1940 | [illegible] DIVISION ENGINEER |
| 5/17/1940 | C. Dudley Corey CHIEF ENGINEER |

DEPT. OF PUBLIC WORKS
DIVISION OF WATER
NEWARK, NEW JERSEY.

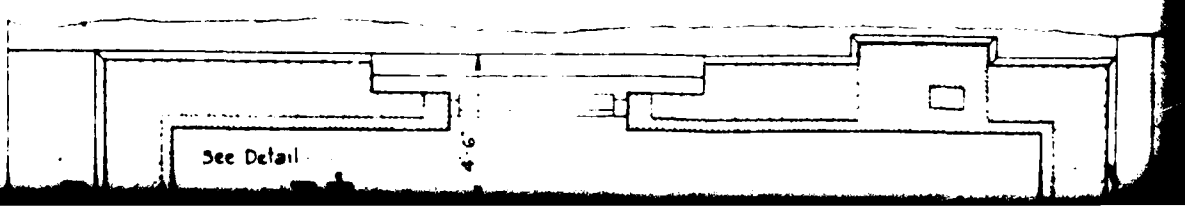
SHEET NO. 1 OF 2.

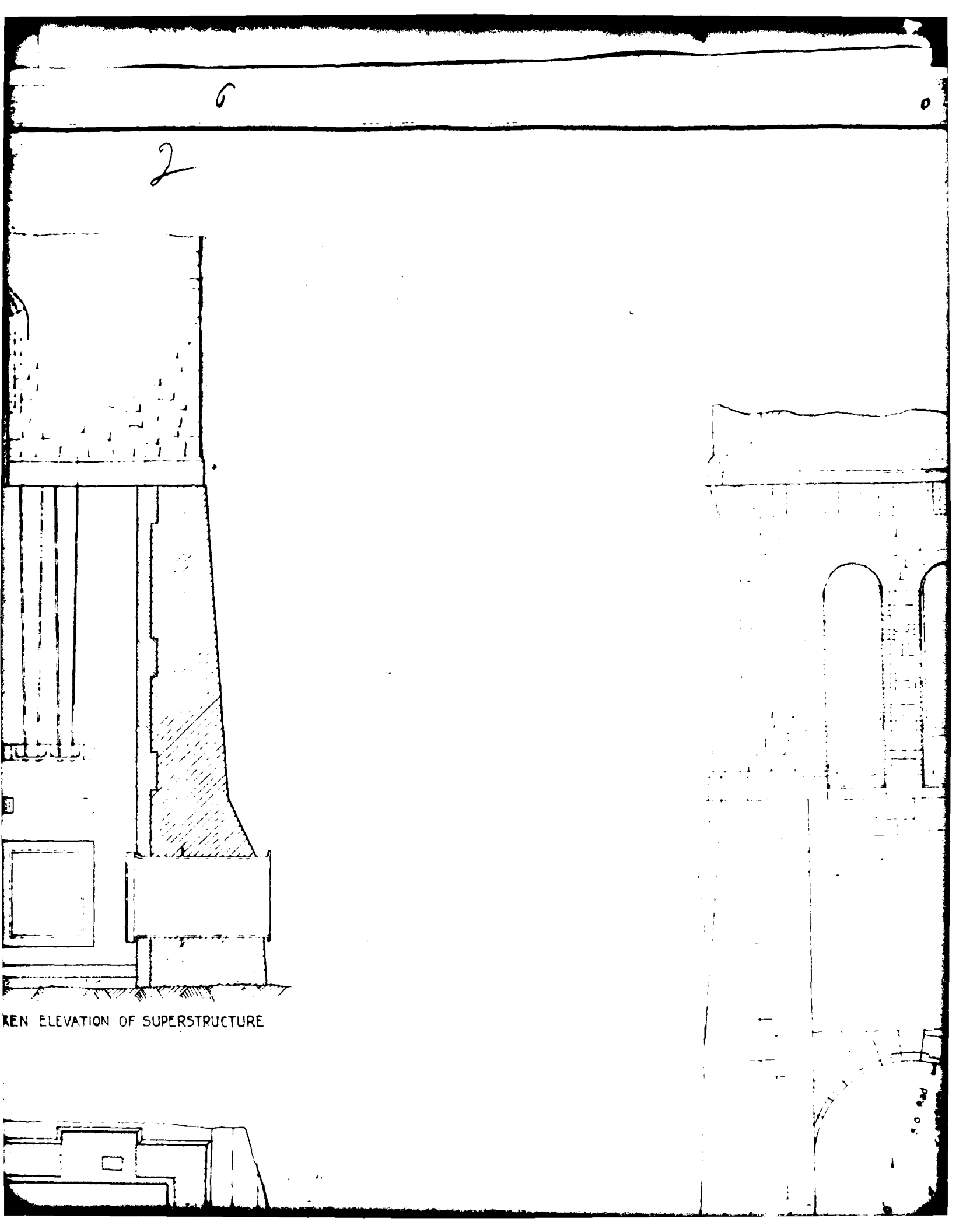
PLATE 4

CASE 2, PKT. 6, FLDR 3, FILE 35, ACC. NO 2947.



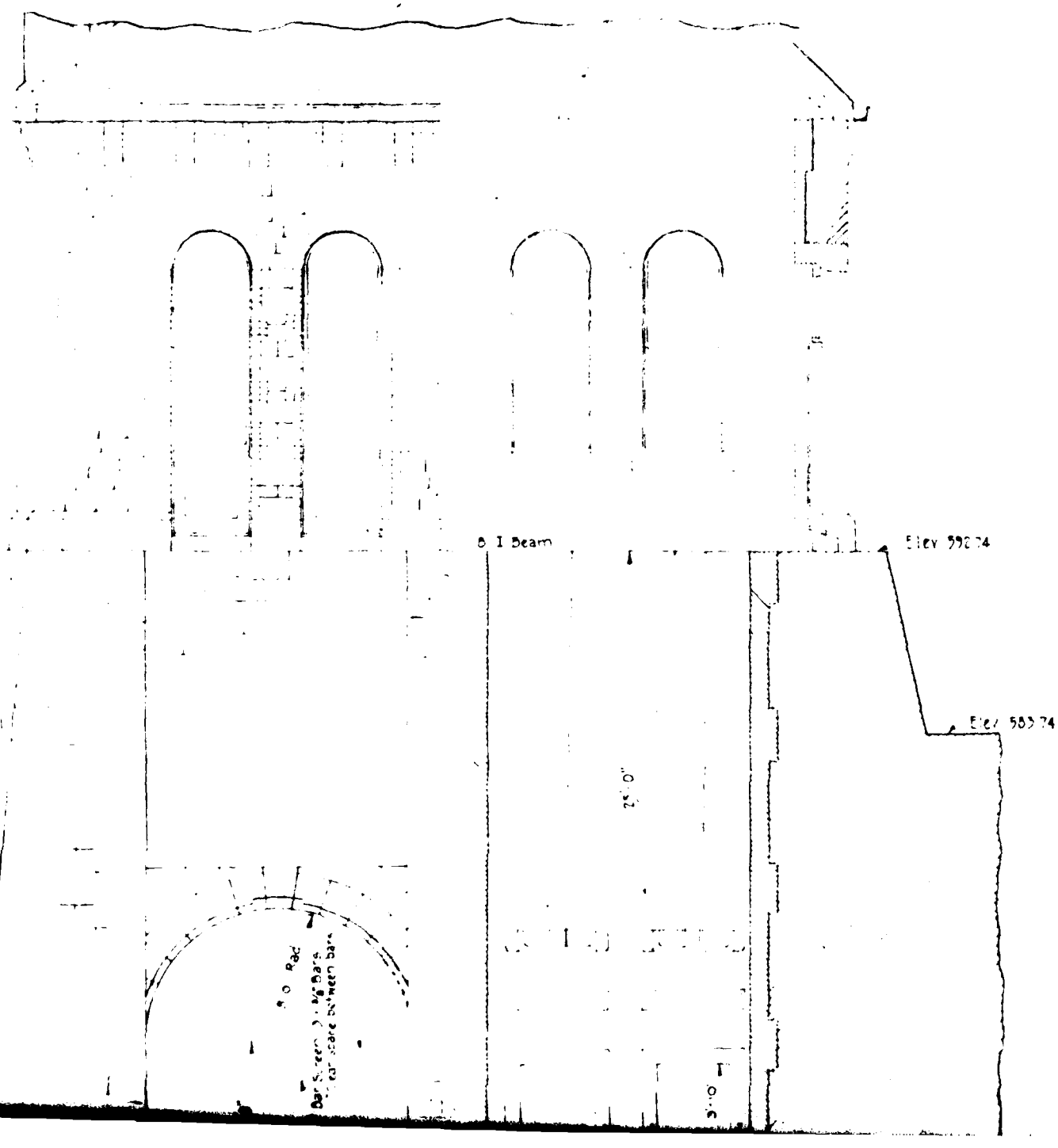

SECTION OF SUBSTRUCTURE ON LINE A-B AND BROKEN ELEVATION OF SUPERSTRUCT

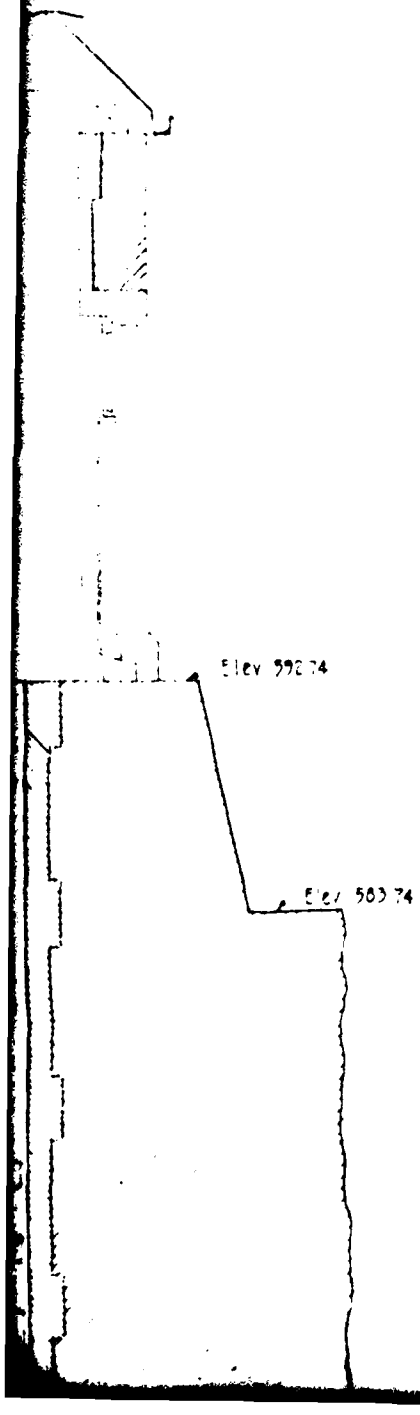


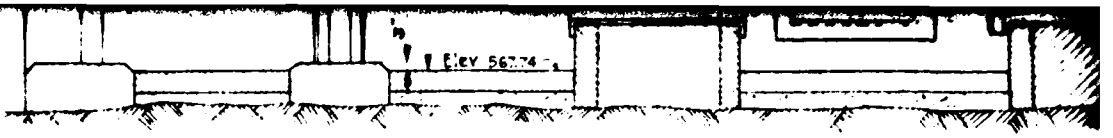


REN ELEVATION OF SUPERSTRUCTURE

3

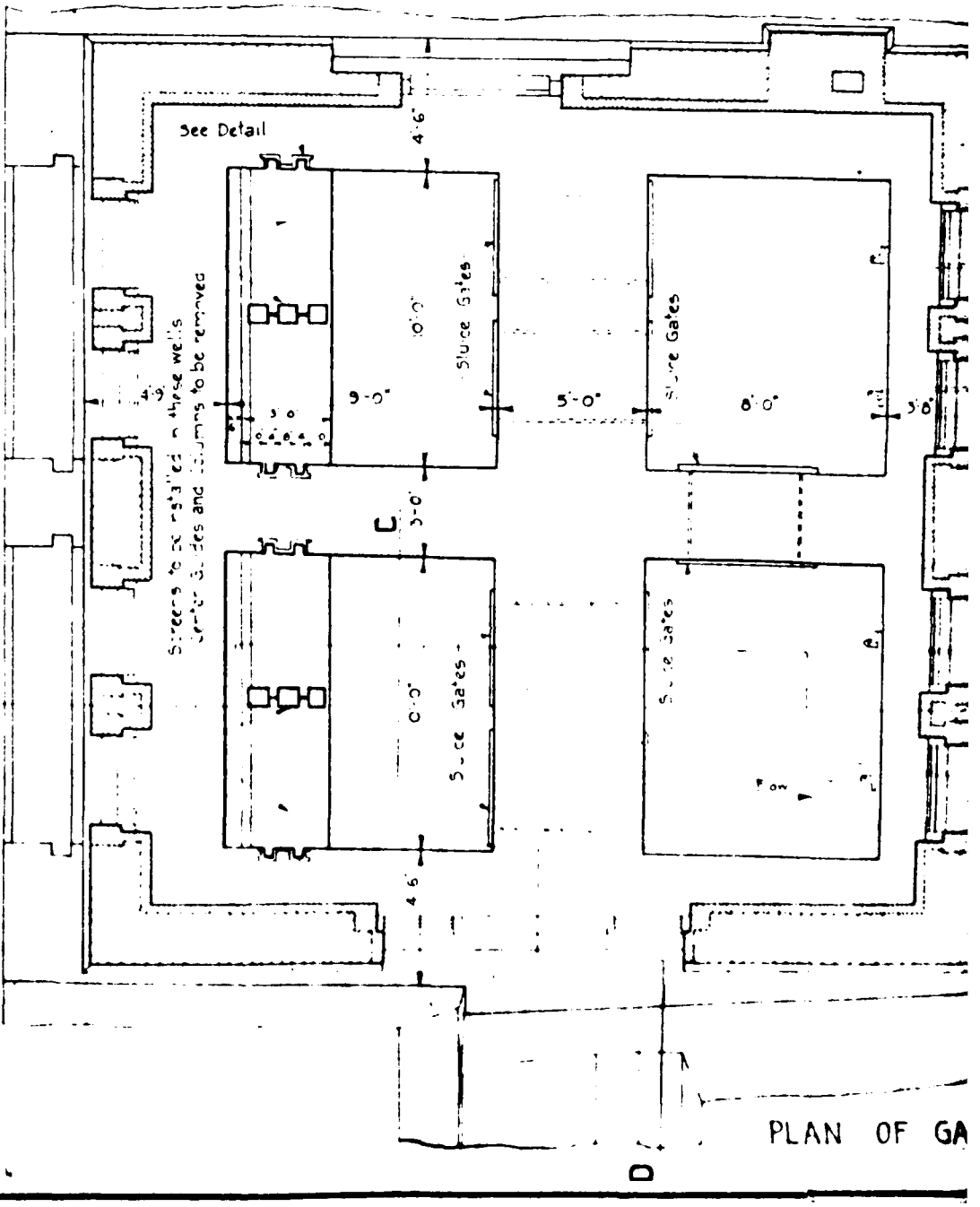



Elev 592.74
Elev 583.74

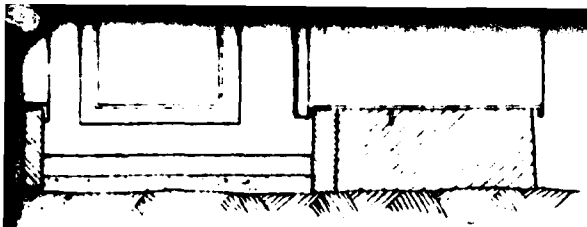



SECTION OF SUBSTRUCTURE ON LINE A-B AND BROKEN ELEVATION OF SUPER

5

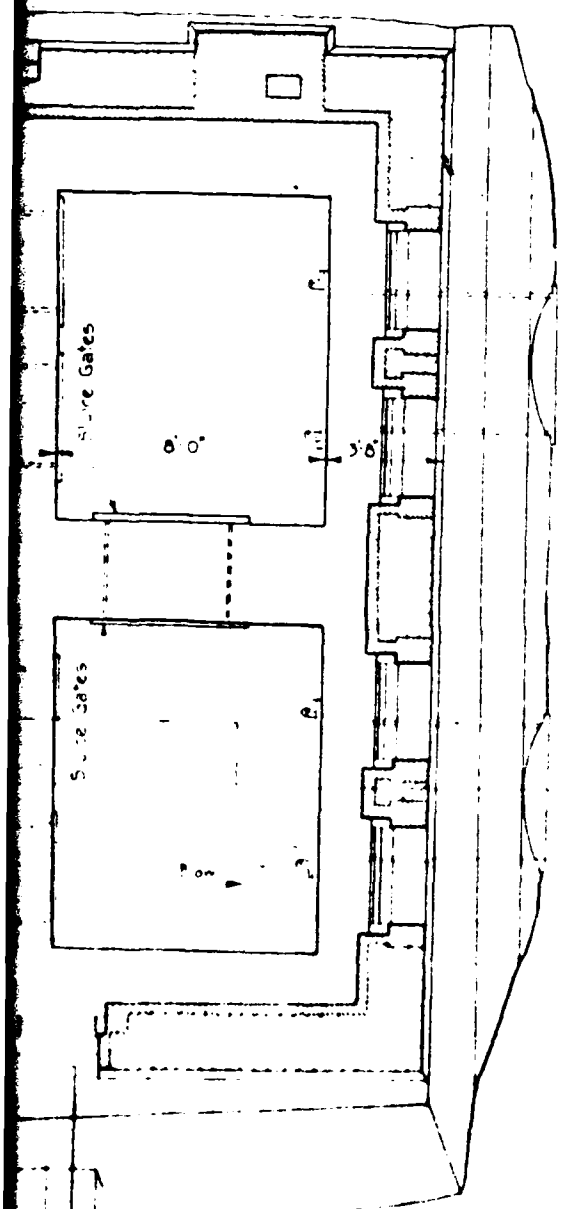



PLAN OF GA

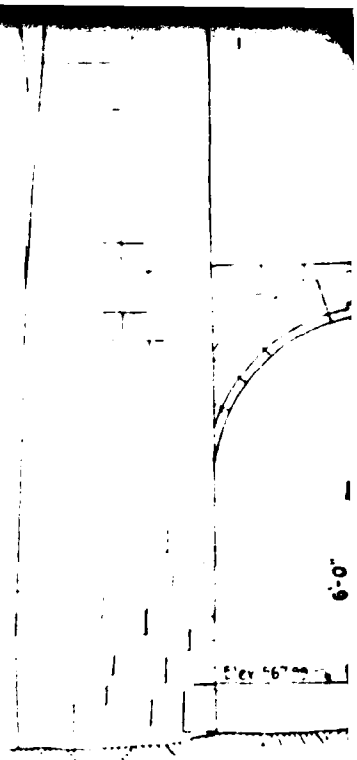


BROKEN ELEVATION OF SUPERSTRUCTURE

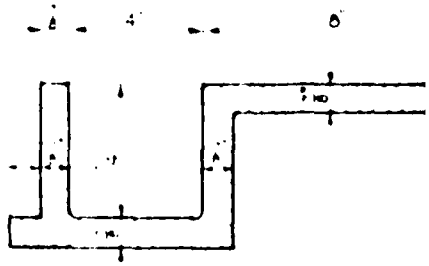
6



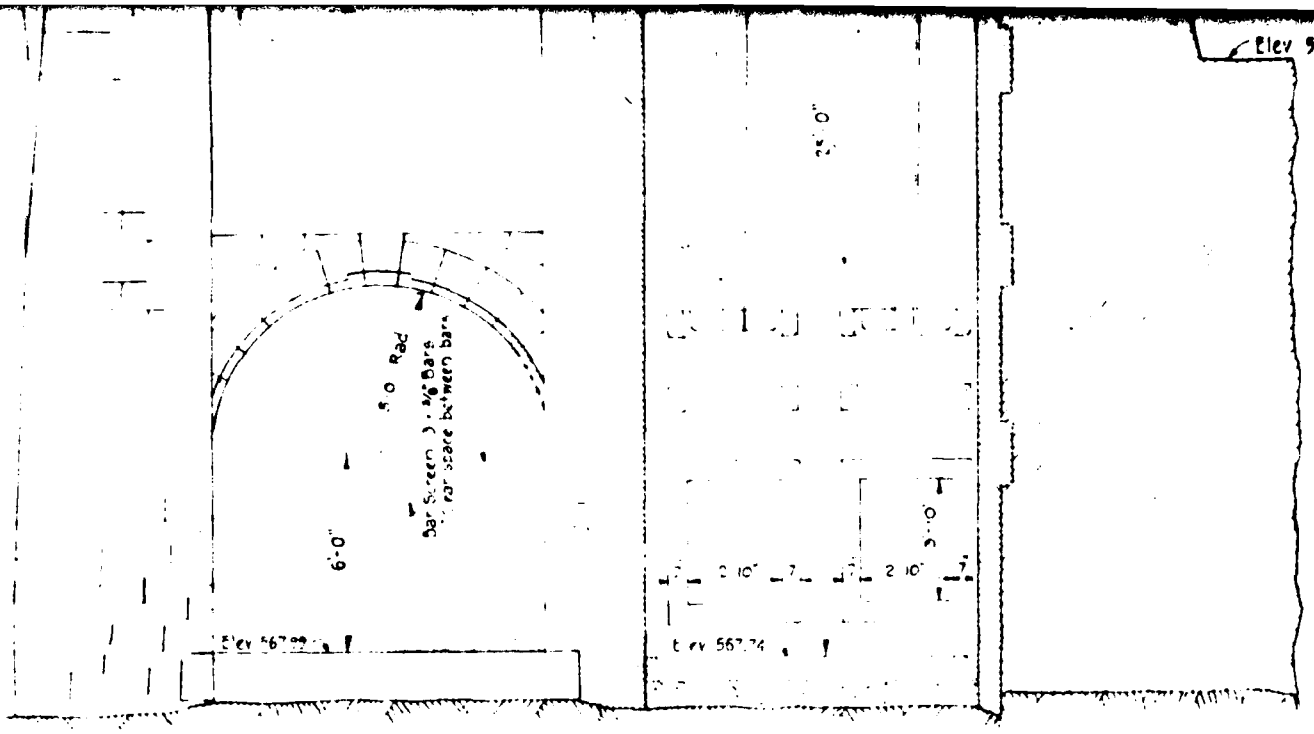

PLAN OF GATEHOUSE




HALF UP-

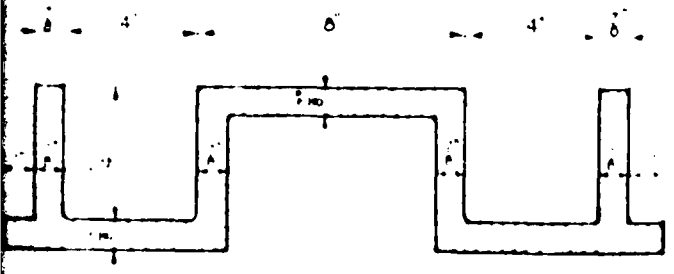


Detail of Screen Gu
Scale 3'=1'




7 HALF UP-STREAM ELEVATION HALF SECTION ON LINE C-D

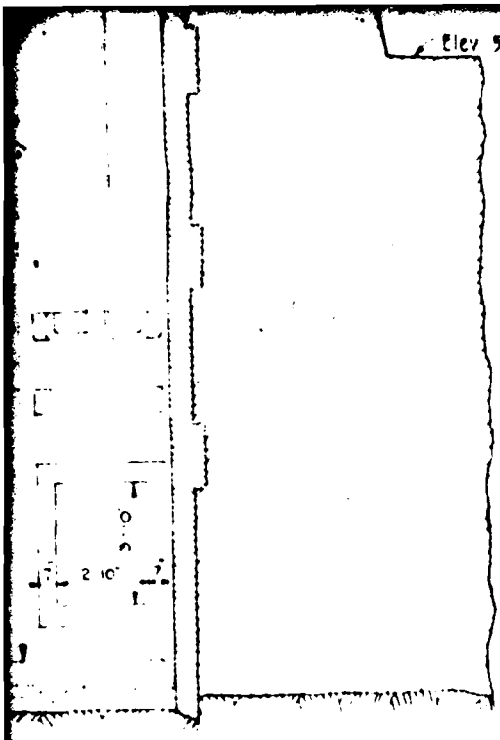
Note :
Contractor shall verify all measurements in field.



Detail of Screen Guide Casting
Scale 3"= 1'



MACO
SCREEN
SCAL
DATE



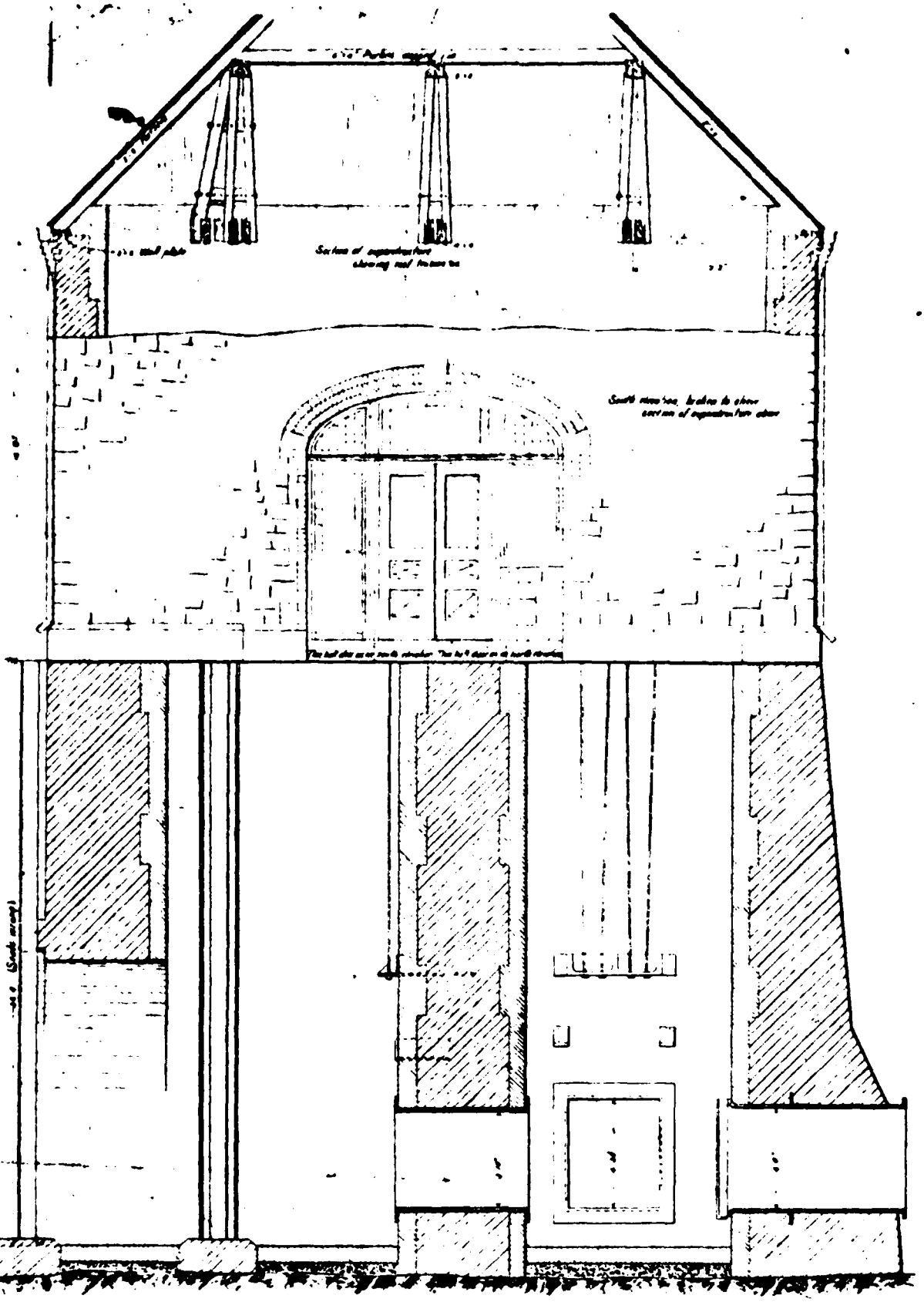

8

ON ON LINE C-D

Note: Contractor shall verify all measurements in field.

REC' 19
NOV 14 1979

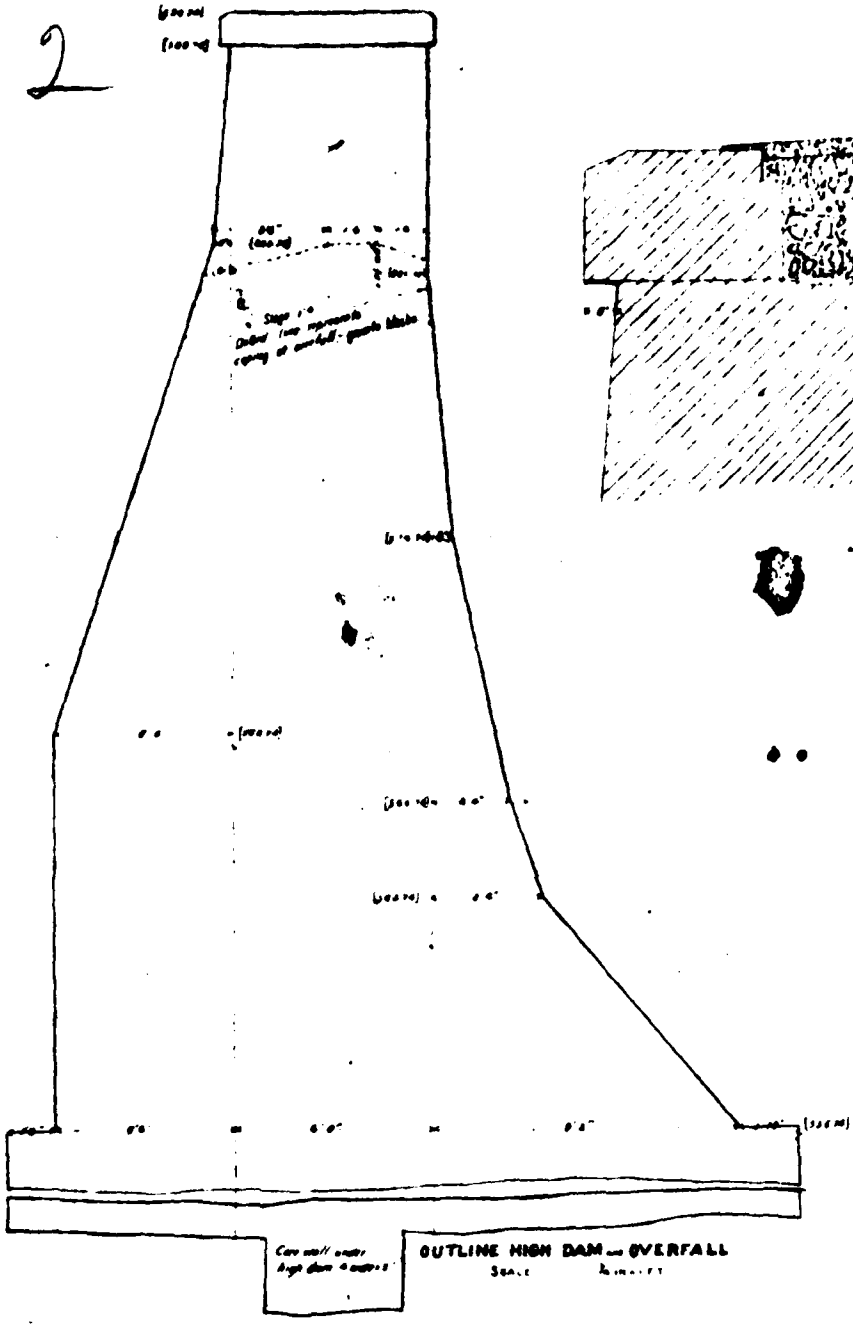
| JOB Nº 3885 | | | | | |
|---|---|---|---|---|---|
| MACOPIN INTAKE GATE HOUSE, MACOPIN, N.J.<br>SCREEN WELLS FOR PROPOSED TRAVELING WATER SCREENS | | | | | |
| SCALE: 1/4" = 1'-0" | | DEPARTMENT OF PUBLIC WORKS<br>DIVISION OF WATER<br>NEWARK, N.J. | | | |
| DATE | APPROVAL | | | | |
| | | SHEET 1 OF 1 | | | |
| | | CASE | PKT | FLDR | FILE | ACCESSION |
| | | 2 | 6 | 3 | 30M | 2096 |



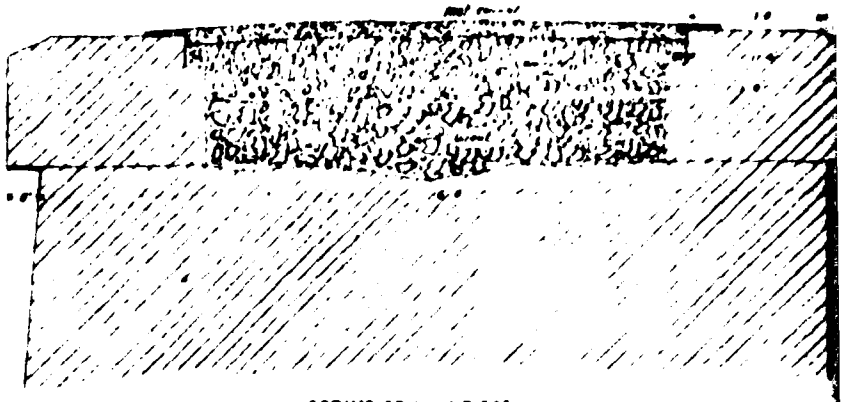
SECTION OF SUBSTRUCTURE ON LINE AB AND BROKEN ELEVATION OF SUPERSTRUCTURE

Scale

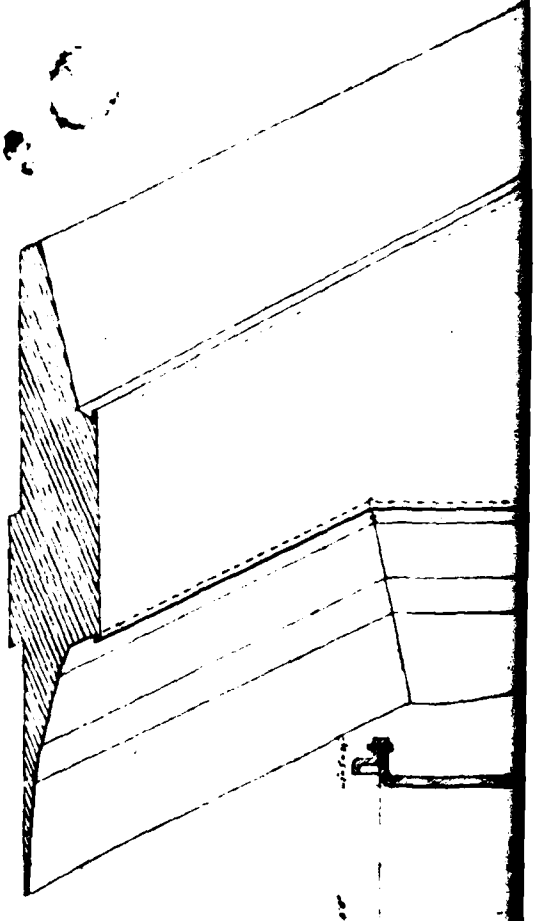
2

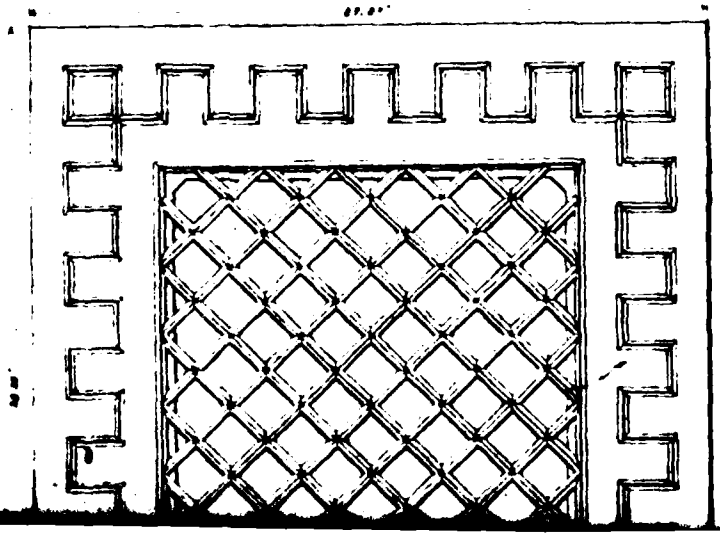


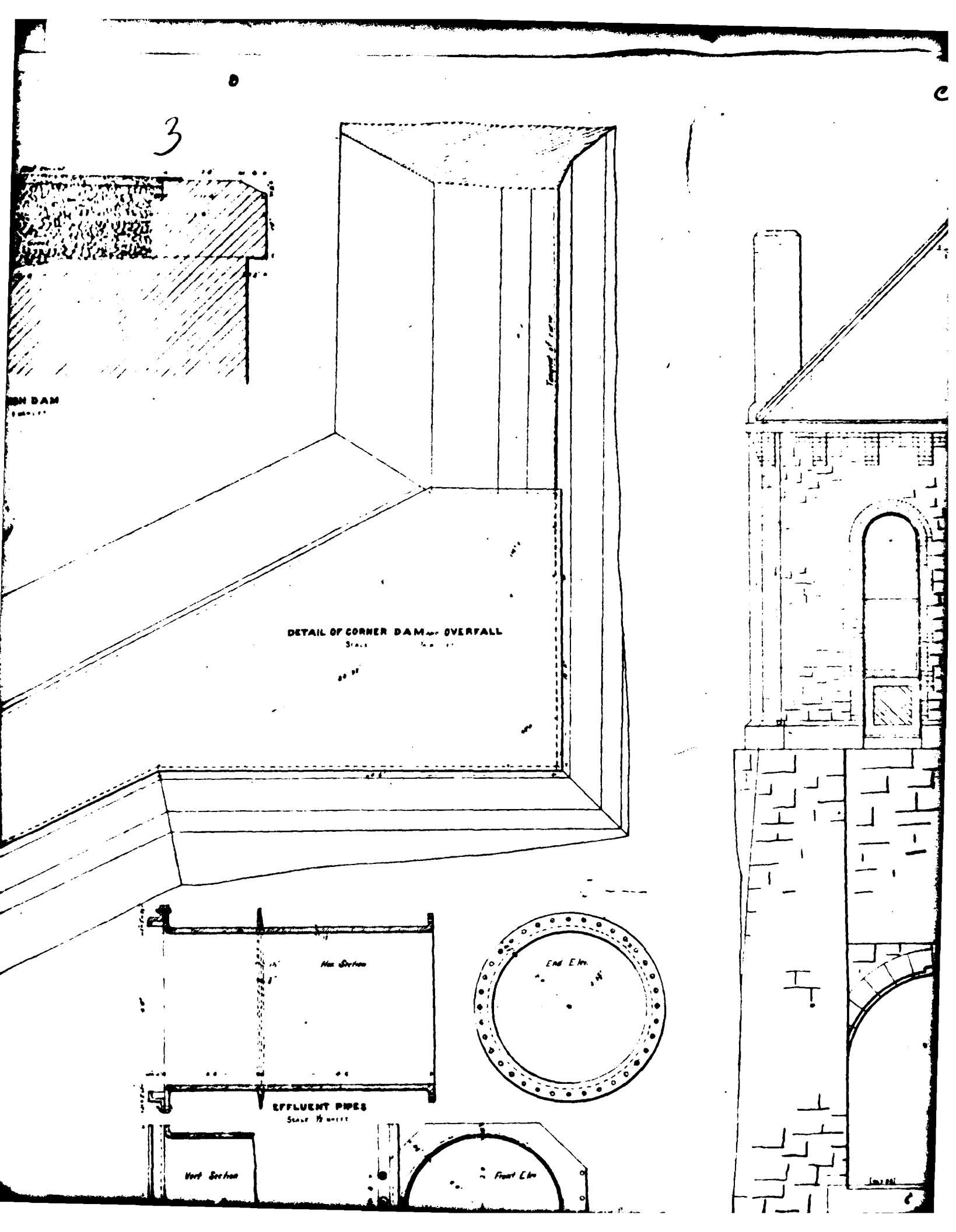
OUTLINE HIGH DAM and OVERFALL

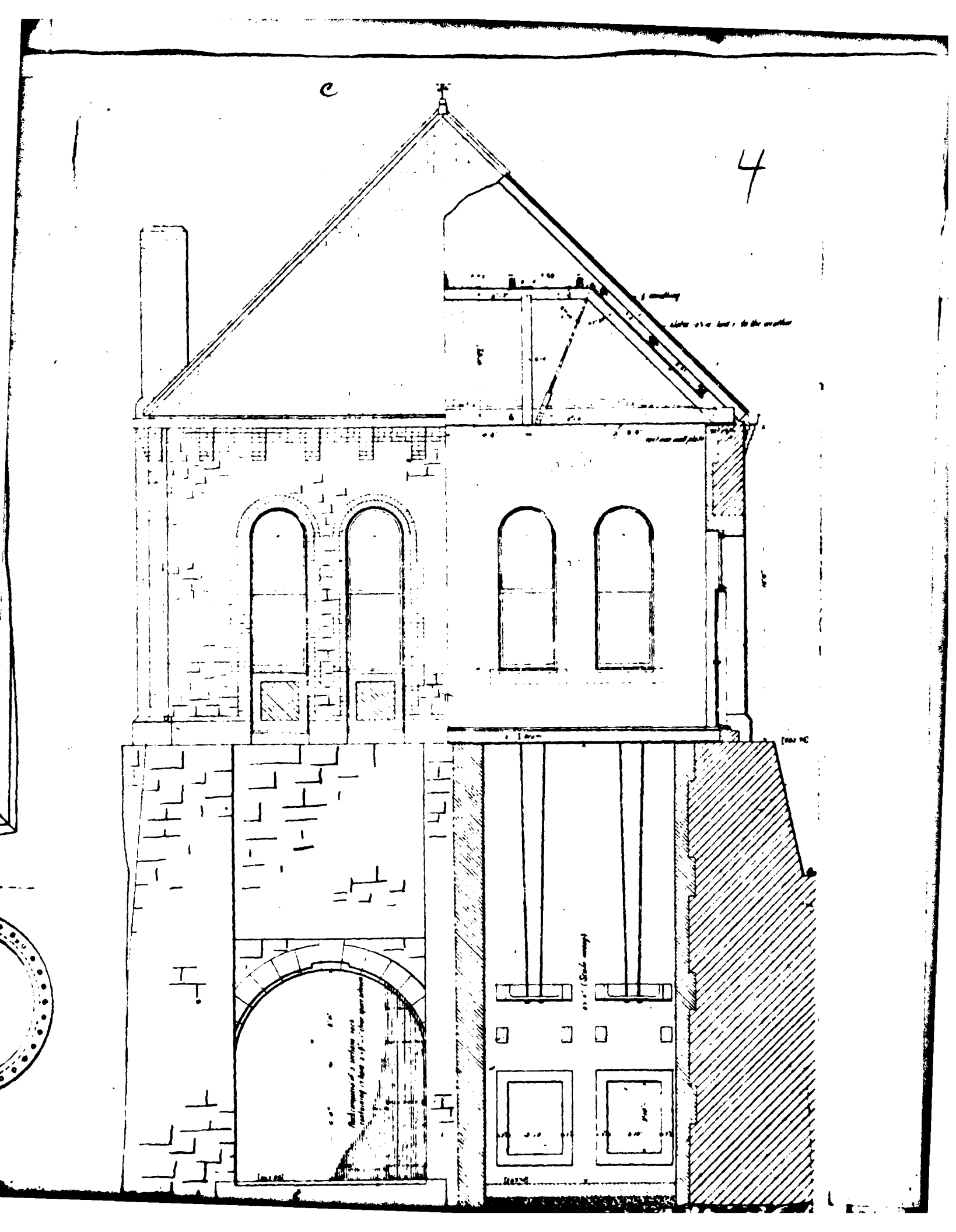


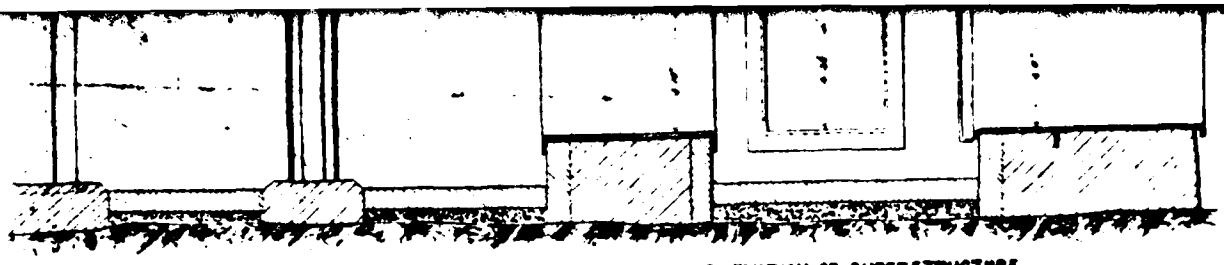
COPING OF HIGH DAM






3
DETAIL OF CORNER DAM and OVERFALL
EFFLUENT PIPES
Vert Section
End Elev.
Front Elev

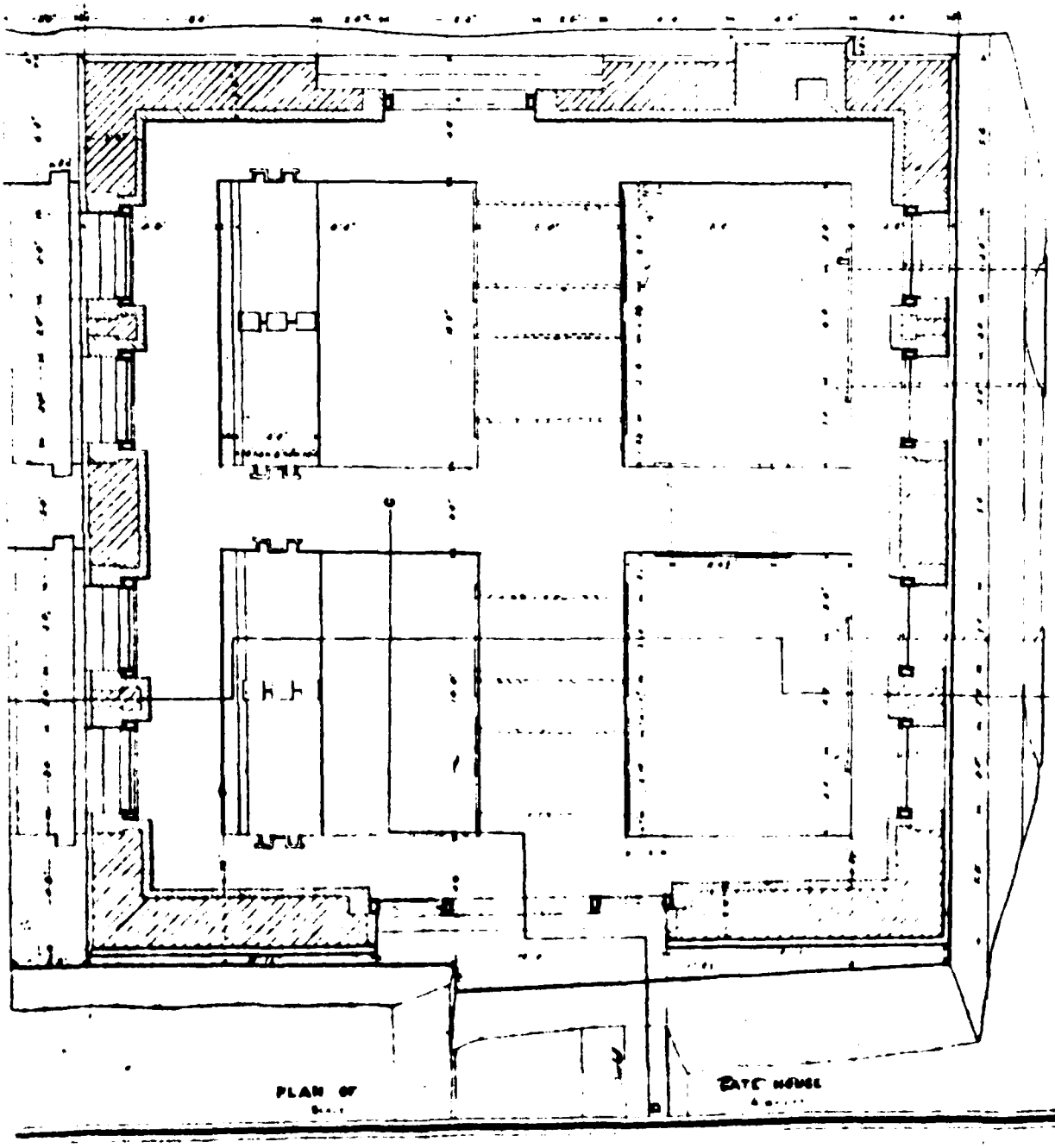




SECTION OF SUBSTRUCTURE ON LINE AB — BROKEN ELEVATION OF SUPERSTRUCTURE

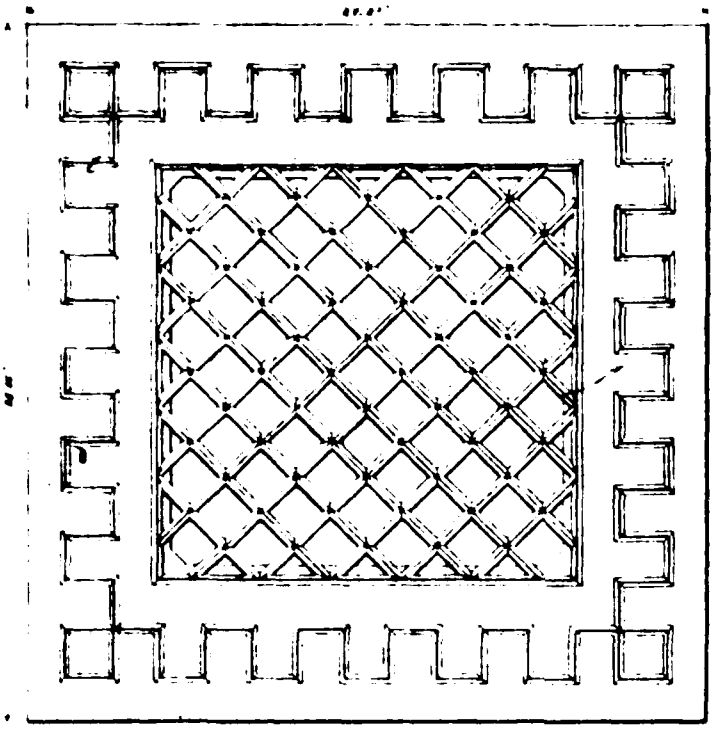
Scale

5

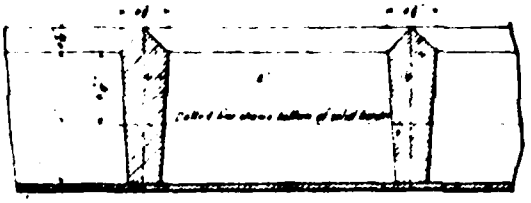


PLAN OF

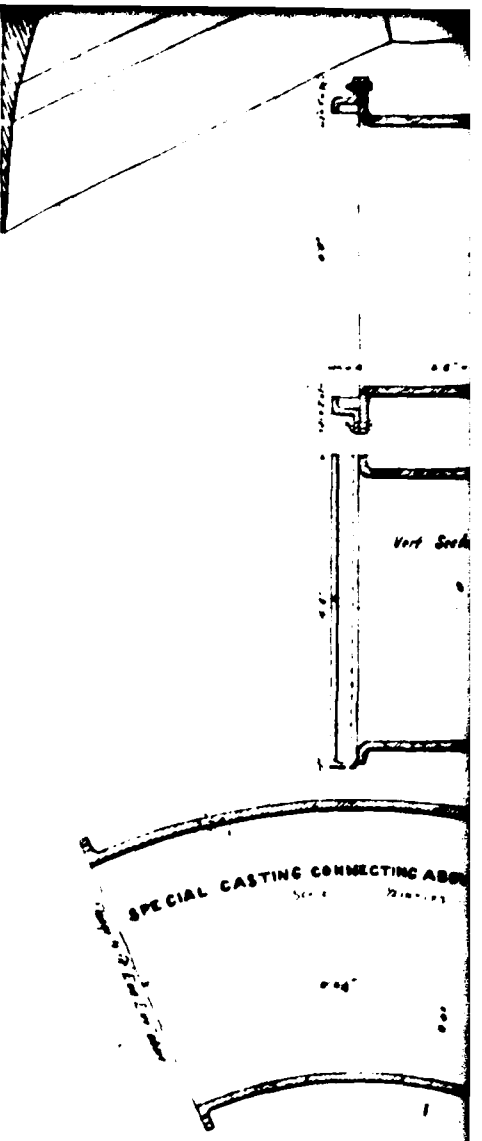
GATE HOUSE

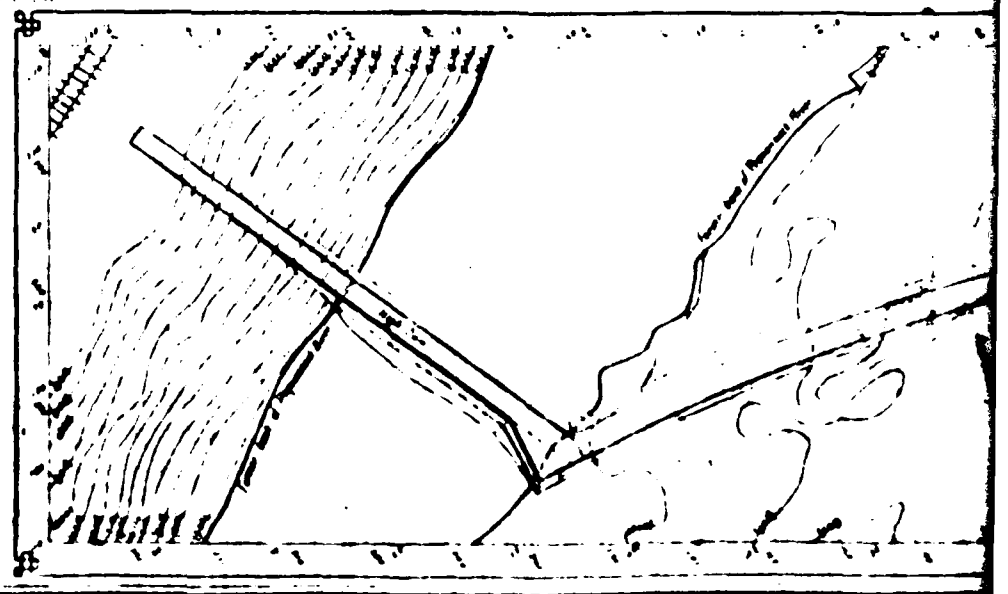


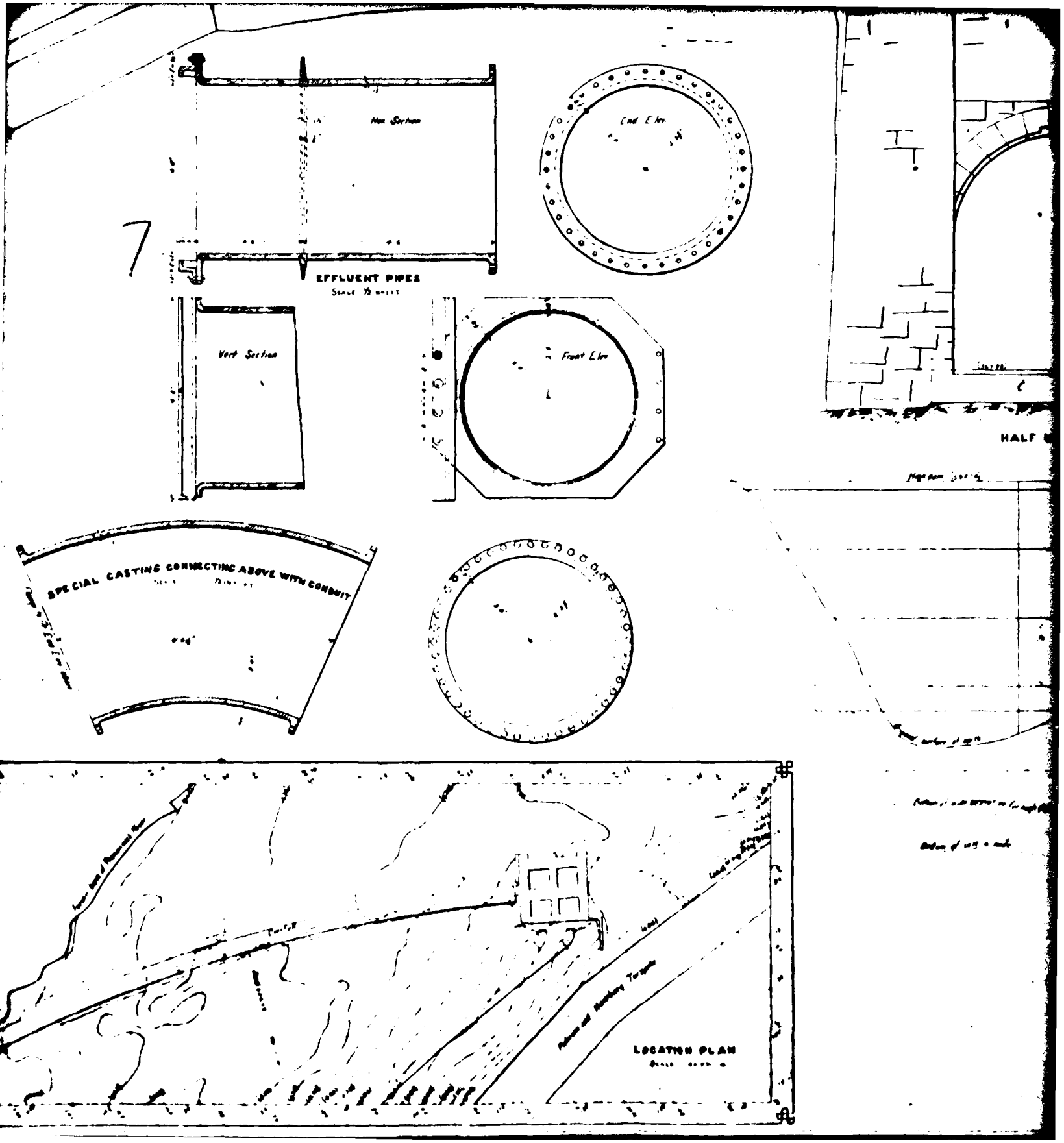
CAST IRON FLOOR PLATES

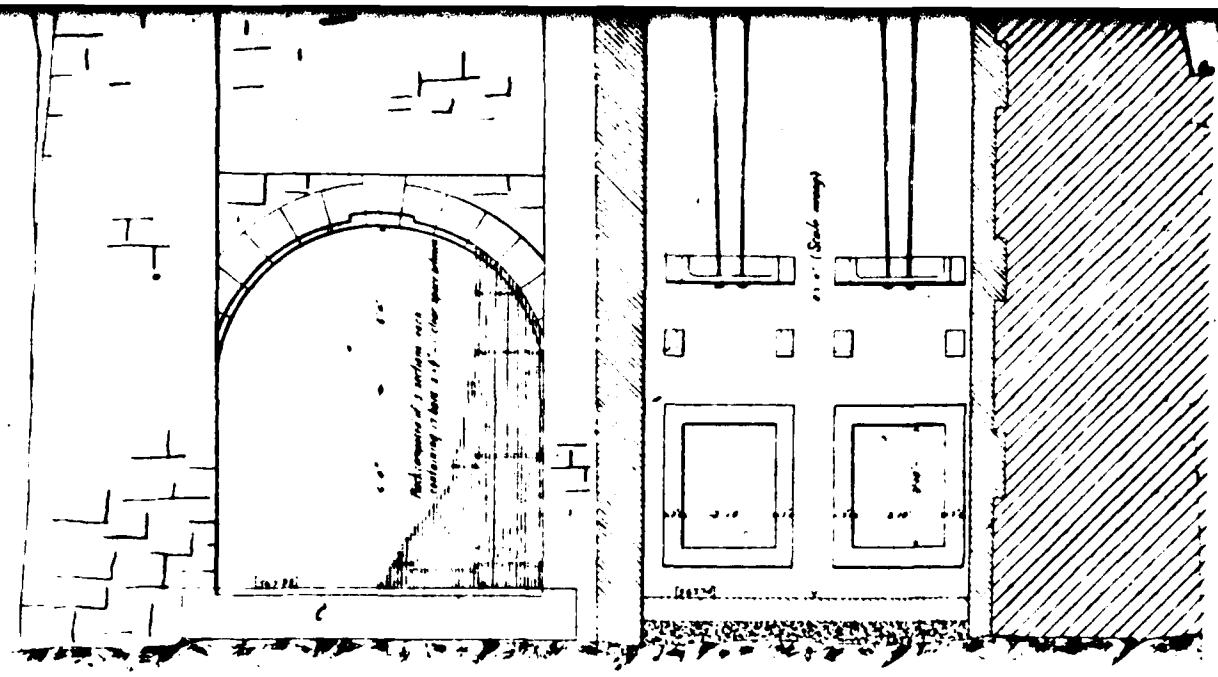


PART SECTION OF THE ABOVE

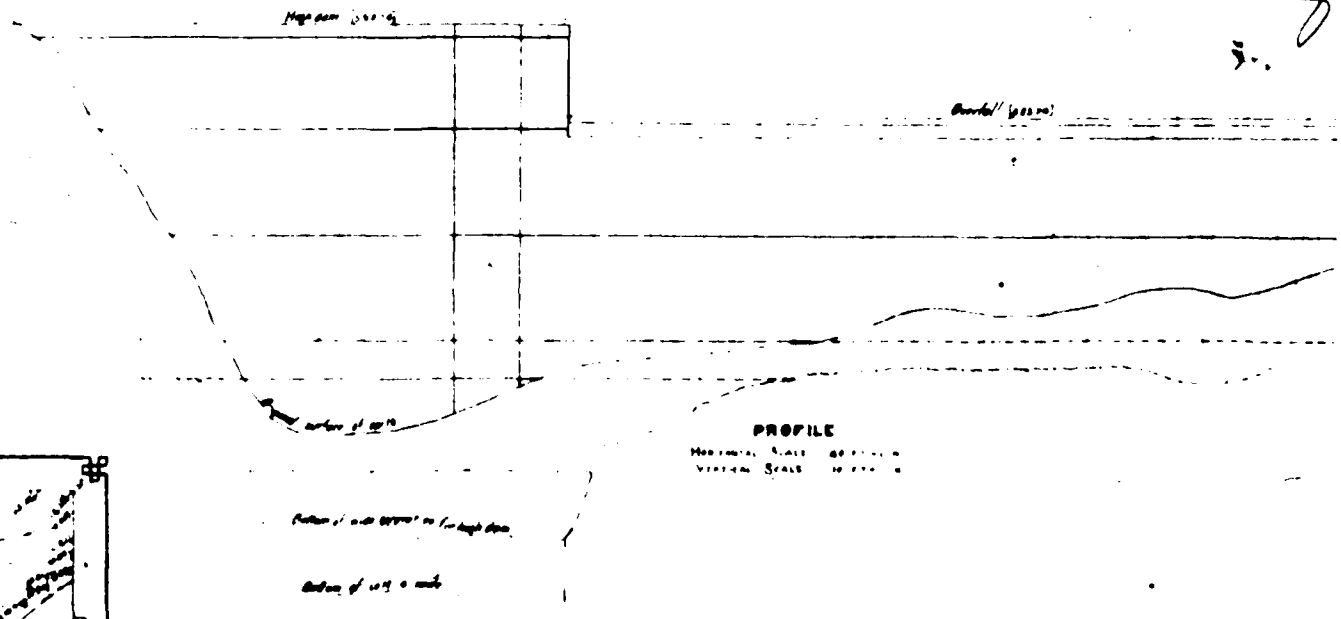



7
Hor Section
End Elev
EFFLUENT PIPES
Vert Section
Front Elev
SPECIAL CASTING CONNECTING ABOVE WITH CONDUIT
HALF
LOCATION PLAN



HALF UP-STREAM ELEVATION HALF SECTION ON LINE C D



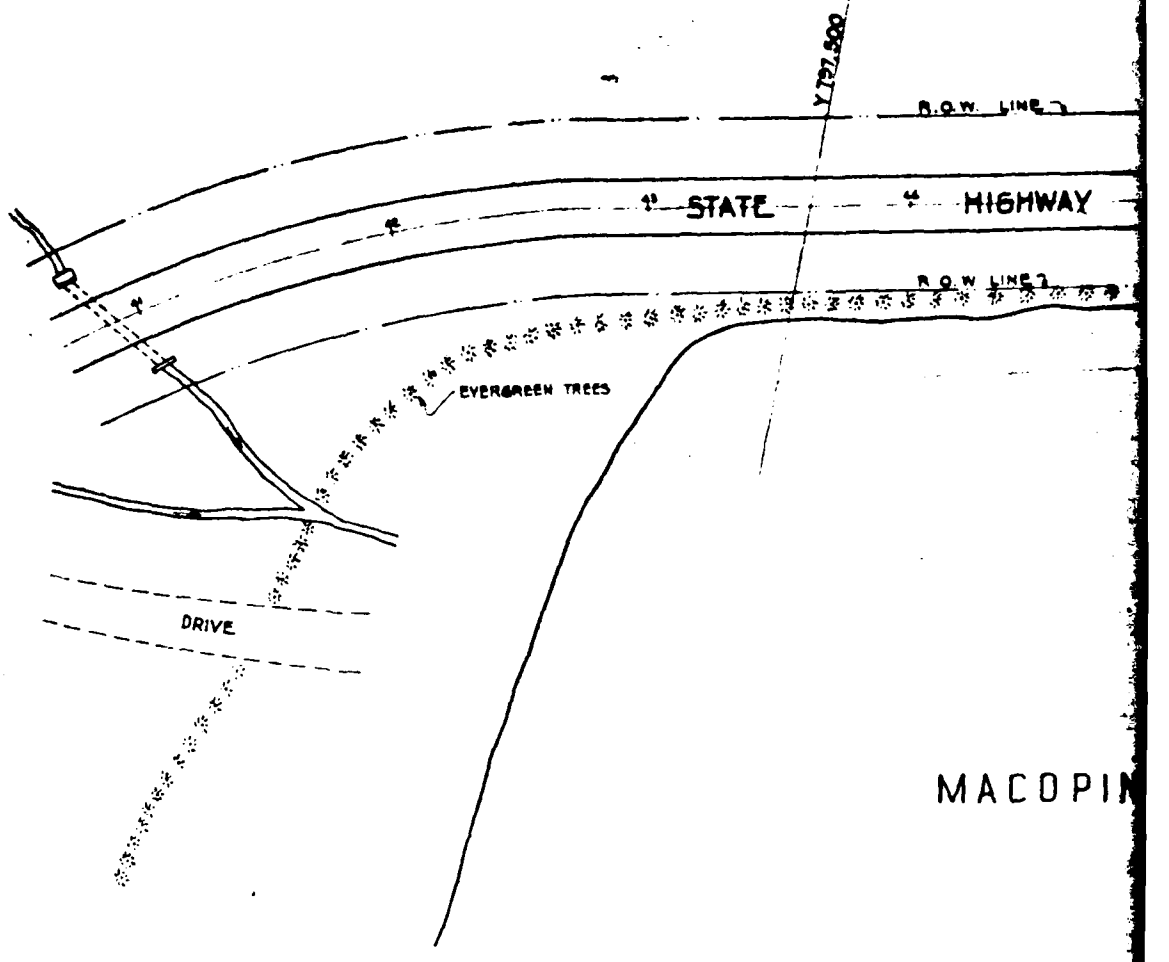
PROFILE

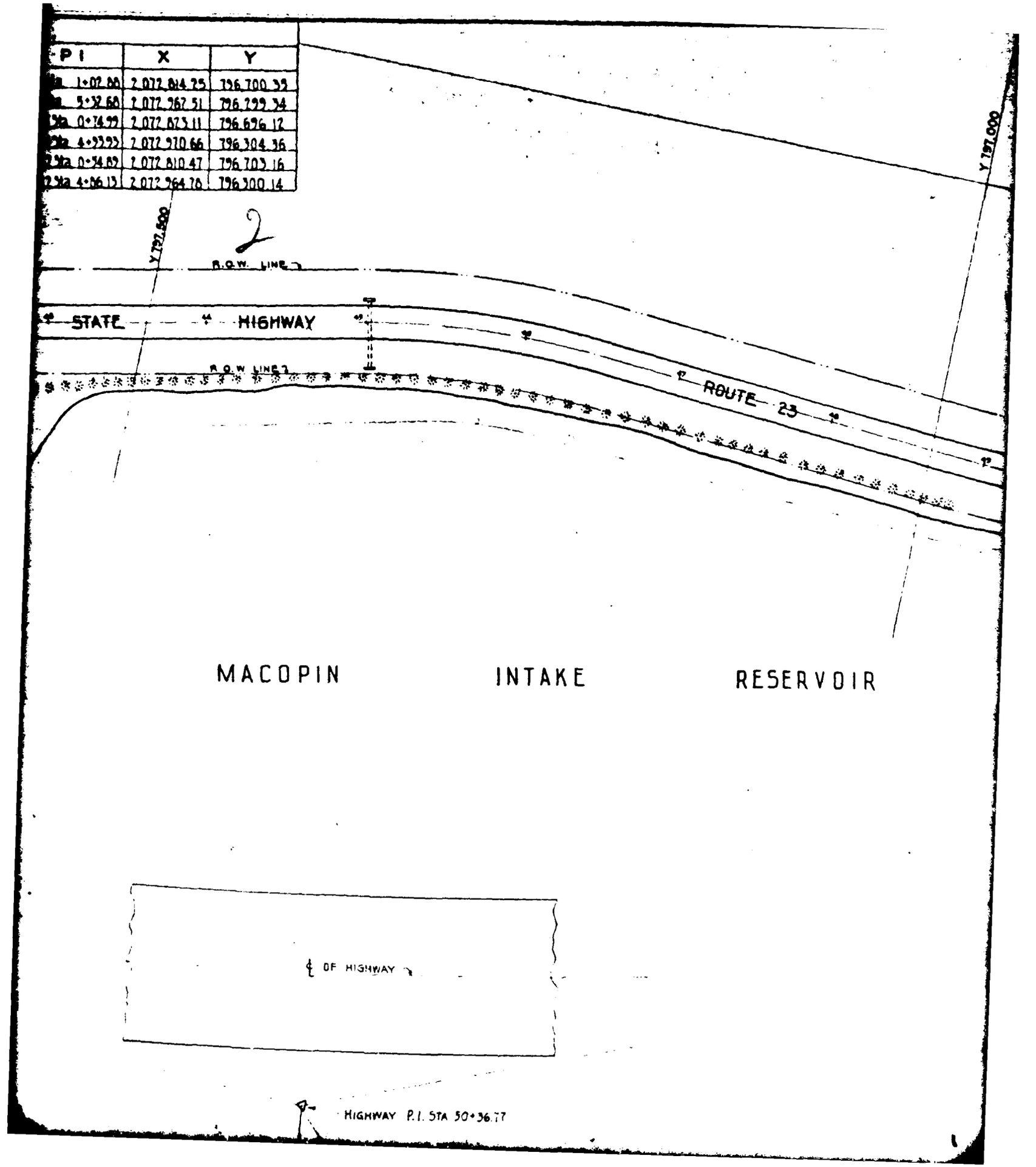
THE EAST JERSEY WATER COMPANY

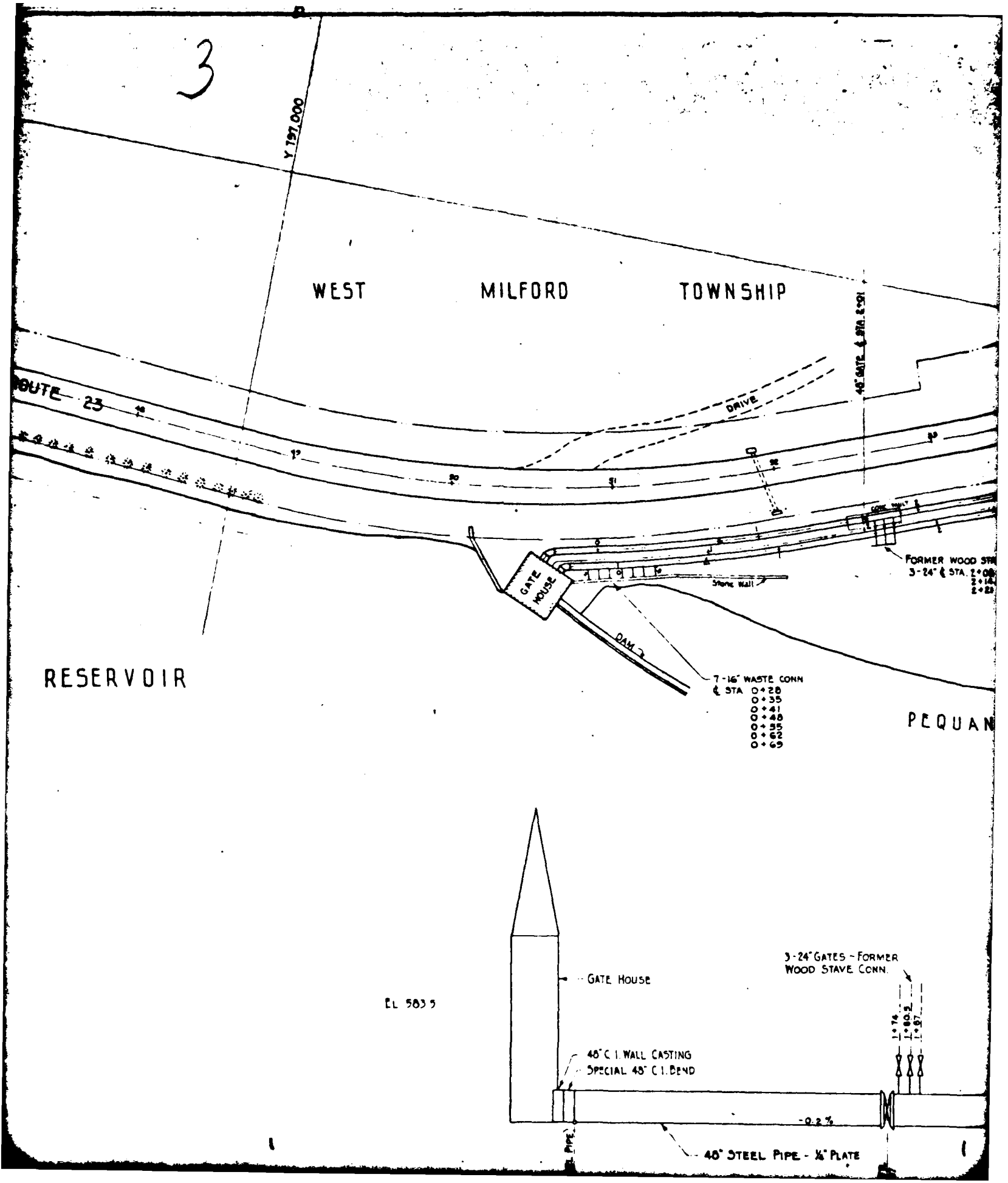
# MACOPIN INTAKE DETAILS

## CURVE DATA

| PC | PT | Δ | R | T | L | PI | X | Y |
|---|---|---|---|---|---|---|---|---|
| ℄ Sta 0+30.76 | ℄ Sta 1+74.79 | 7° 12' 00" Lt | 1146.3 | 72.12 | 144.03 | ℄ Sta 1+02.88 | 2,072,814.25 | 796,700.35 |
| ℄ Sta 2+76.20 | ℄ Sta 7+58.43 | 48° 10' 30" Lt | 573.7 | 256.48 | 482.23 | ℄ Sta 5+32.68 | 2,072,967.51 | 796,799.34 |
| No.1 Sta 0+17.9 | No.1 Sta 1+32.0 | 5° 44' 00" Lt | 1140.3 | 57.09 | 114.1 | No.1 Sta 0+74.99 | 2,072,823.11 | 796,696.12 |
| No.1 Sta 2+38.4 | No.1 Sta 7+18.6 | 48° 20' 00" Lt | 567.7 | 255.53 | 480.2 | No.1 Sta 4+93.93 | 2,072,970.66 | 796,304.36 |
| No.2 Sta 0+13.4 | No.2 Sta 1+23.3 | 7° 15' Lt | 1077.8 | 68.29 | 136.7 | No.2 Sta 0+54.89 | 2,072,810.47 | 796,703.16 |
| No.2 Sta 2+23.9 | No.2 Sta 7+16.2 | 48° 10' Lt | 582.2 | 260.23 | 490.3 | No.2 Sta 4+86.13 | 2,072,964.78 | 796,300.14 |



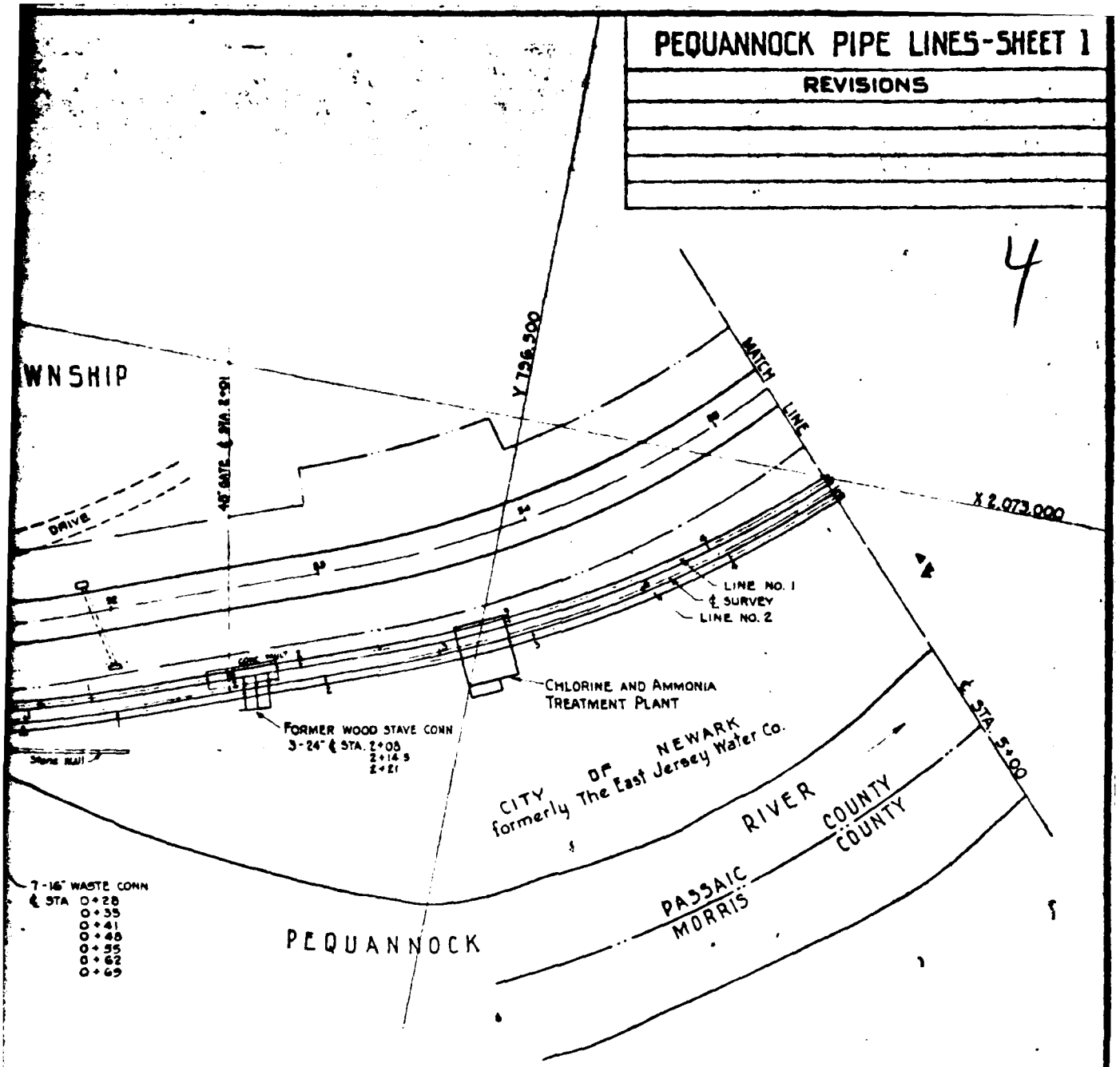

P I | X | Y
1+02.88 | 2,072,814.75 | 796,700.39
5+32.68 | 2,072,767.51 | 796,729.34
0+74.99 | 2,072,823.11 | 796,696.12
4+33.93 | 2,072,970.66 | 796,304.36
0+34.89 | 2,072,810.47 | 796,703.16
4+06.13 | 2,072,964.76 | 796,300.14
Y 797,500
Y 797,000
R.O.W. LINE
STATE HIGHWAY
R.O.W. LINE
ROUTE 23
MACOPIN INTAKE RESERVOIR
℄ OF HIGHWAY
HIGHWAY P.I. STA 50+36.77

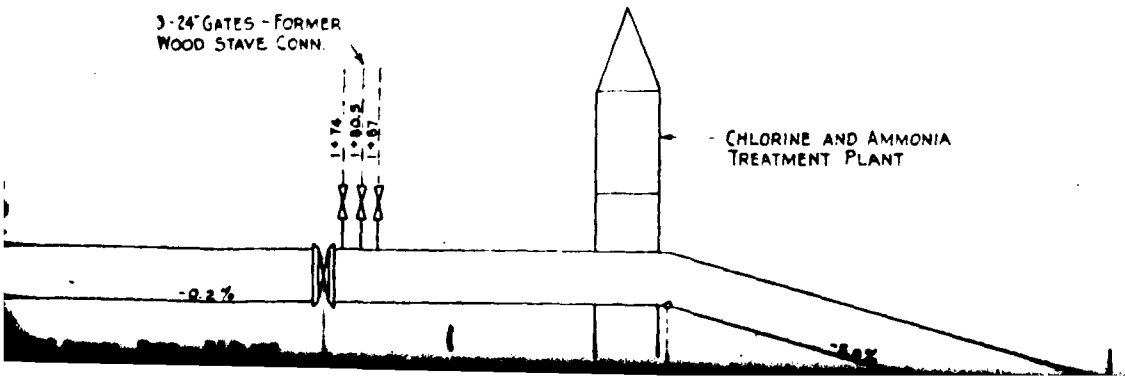

3
Y 197,000
WEST MILFORD TOWNSHIP
ROUTE 23
DRIVE
40" GATE & STA. 2+91
GATE HOUSE
Stone Wall
DAM
FORMER WOOD STR
3-24" & STA. 2+08
2+14
2+23
RESERVOIR
7-16" WASTE CONN
℄ STA 0+28
0+35
0+41
0+48
0+55
0+62
0+69
PEQUAN
EL 583.5
GATE HOUSE
3-24" GATES - FORMER WOOD STAVE CONN.
1+74
1+80.2
1+87
40" C.I. WALL CASTING
SPECIAL 48" C.I. BEND
-0.2%
40" STEEL PIPE - ½" PLATE

# PEQUANNOCK PIPE LINES-SHEET 1

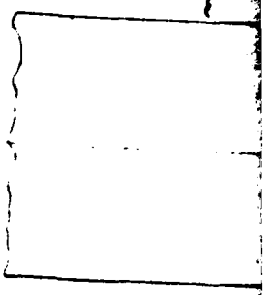
| REVISIONS |
| --- |
| |
| |
| |
| |

4

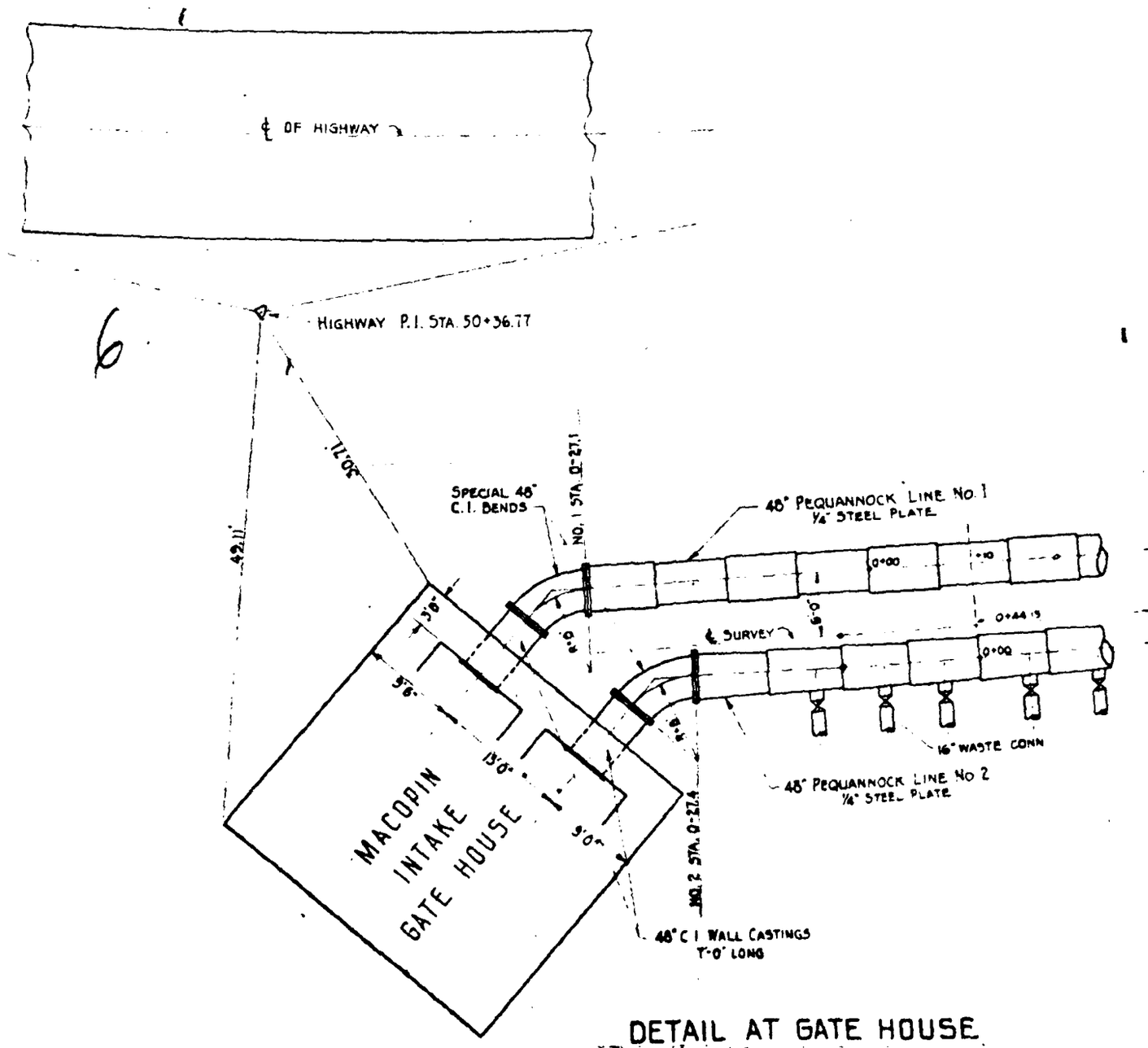


5



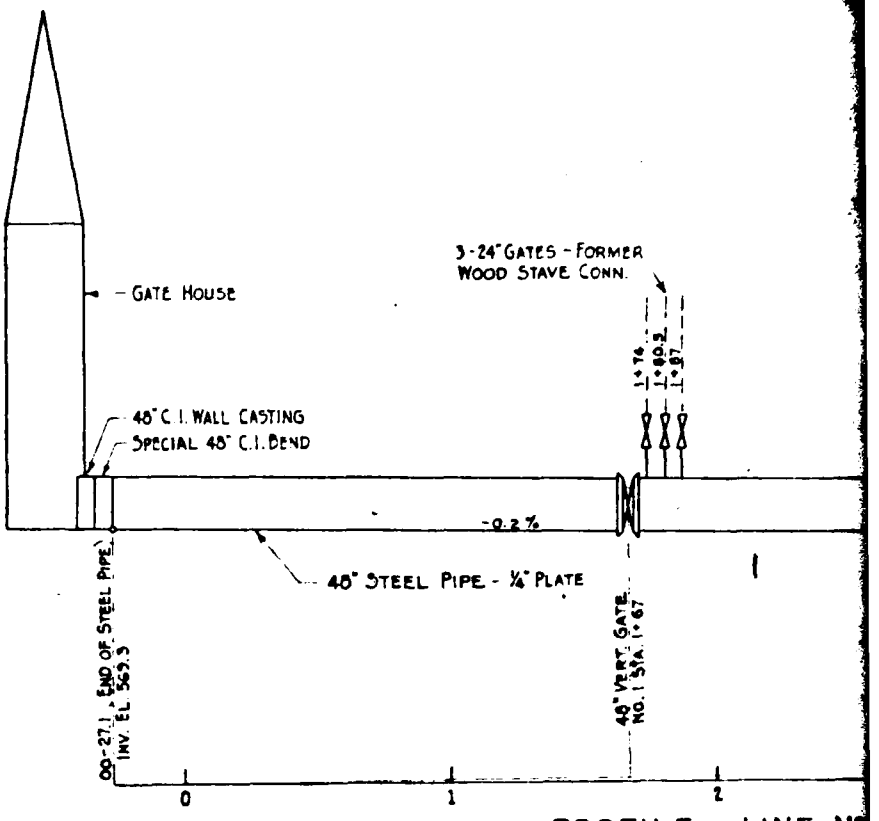
R. B. Thompson
E. T. Erickson



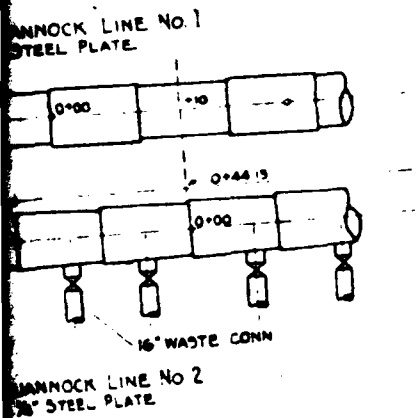

DETAIL AT GATE HOUSE

SCALE 1" = 10'

7

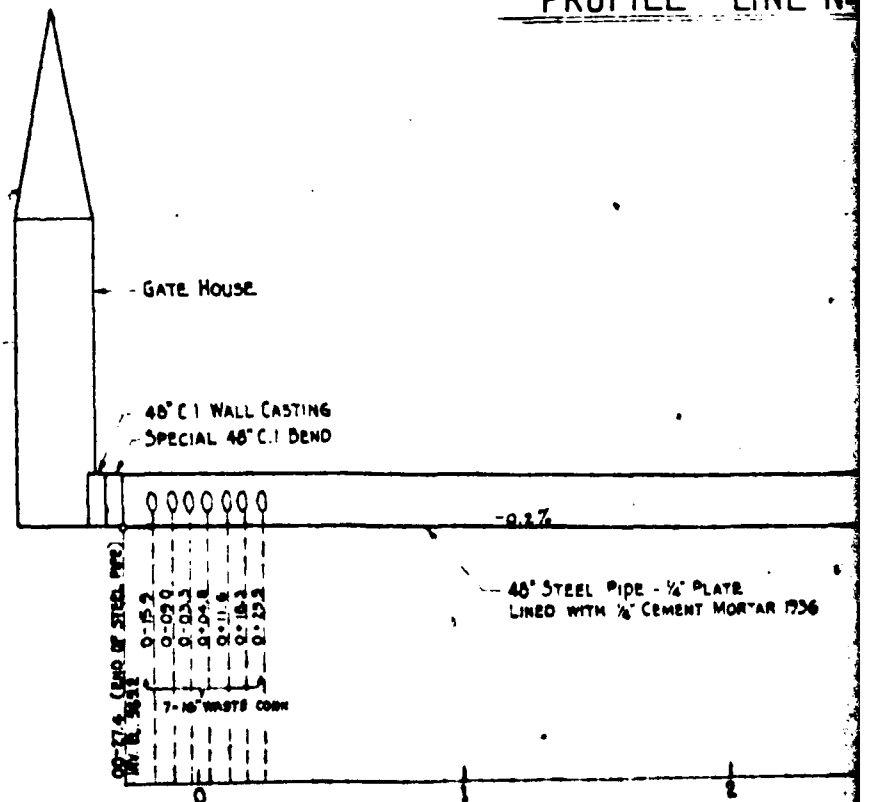



PROFILE - LINE N



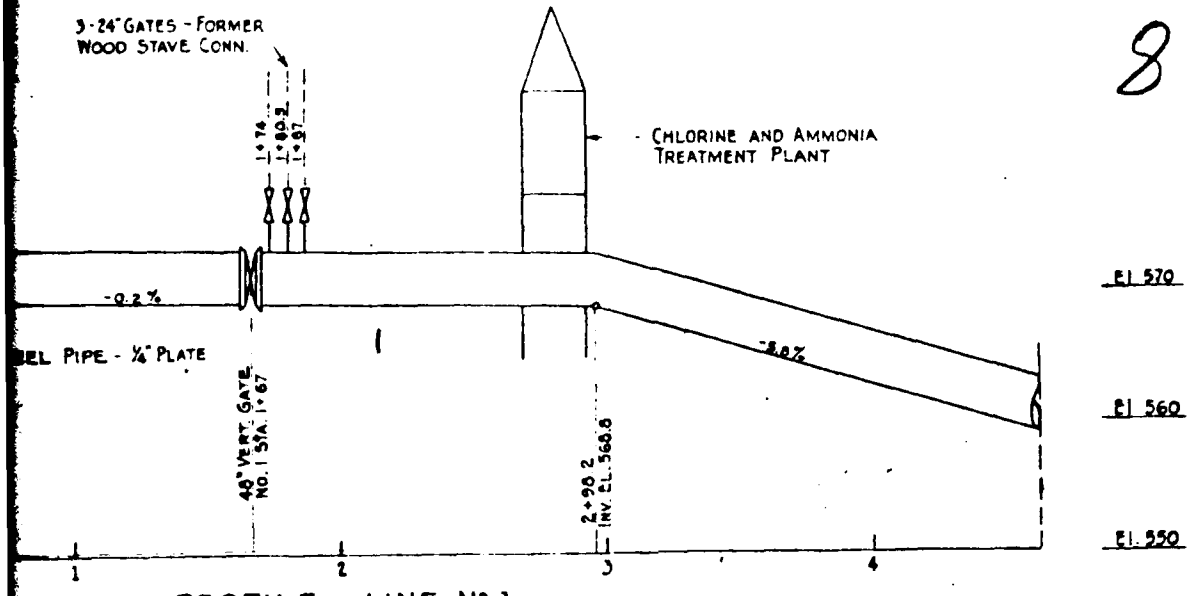

NNOCK LINE NO. 1
STEEL PLATE

NNOCK LINE NO 2
" STEEL PLATE

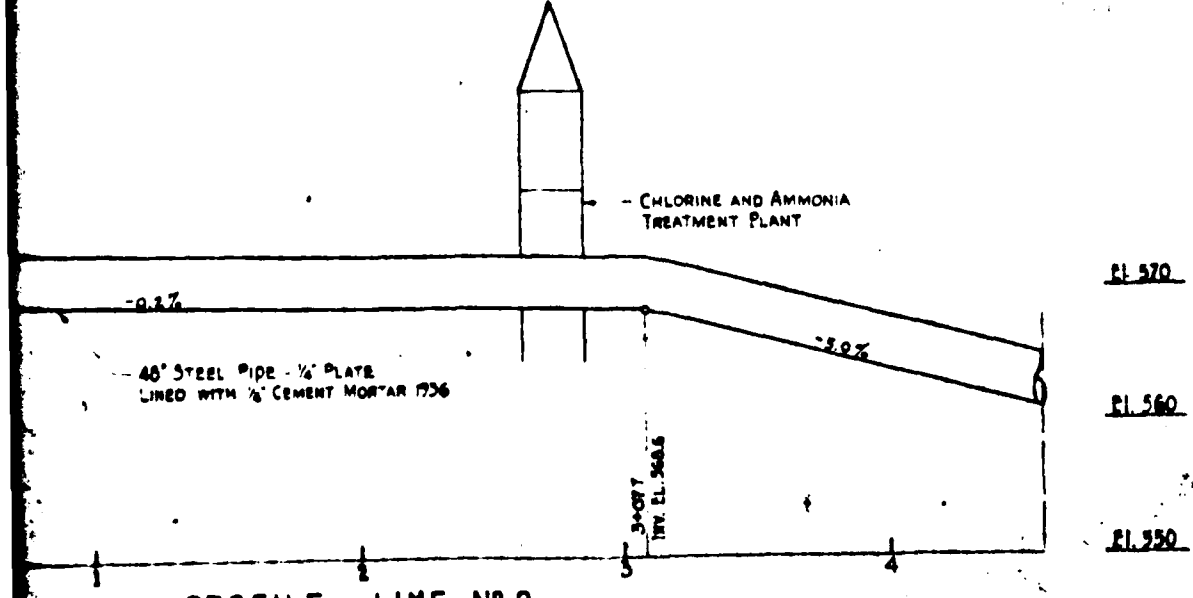



PROFILE - LINE N

E HOUSE
10'




PROFILE - LINE Nº 1




PROFILE - LINE Nº 2

# APPENDIX A

## CHECK LIST - VISUAL OBSERVATIONS

## CHECK LIST - ENGINEERING, CONSTRUCTION MAINTENANCE DATA

CHECK LIST
VISUAL INSPECTION
PHASE 1

Name Dam Macopin Reservoir Dam County Passaic State New Jersey Coordinators NJ-DEP

Date(s) Inspection November 21, 1979
December 4, 1979
Weather Sunny Temperature 50° F

Pool Elevation at Time of Inspection 581.9 NGVD Tailwater at Time of Inspection 562.5 NGVD

Inspection Personnel:

November 21, 1979:
Chuck Chin
Eugene Koo (Recorder)
Thomas Lakovich

December 4, 1979:
Chuck Chin
James McCormick

Owner/Representative:

December 4, 1979:

Glen Norman, Maintenance Foreman
City of Newark
Department of Public Works
Division of Water Supply
1294 McBride Avenue
Little Falls, N.J. 07424

CONCRETE/MASONRY DAMS

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| SEEPAGE OR LEAKAGE | None observed. | |
| STRUCTURE TO ABUTMENT/ EMBANKMENT JUNCTIONS | Good condition. Slight spalling was noticed on downstream side at junction of spillway and dam. | Repair spalling |
| DRAINS | None. | |
| WATER PASSAGES | See "OUTLET WORKS" | |
| FOUNDATIONS | Rock | |

CONCRETE/MASONRY DAMS

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| SURFACE CRACKS<br>CONCRETE SURFACES | Longitudinal cracks and spalling were noticed in the concrete cap of the dam. The downstream side of the dam and wingwall are stone masonry; the upstream sides are faced with concrete (gunite). Stone masonry and gunite are in good condition. The wingwall is located at the left end of the dam, extending from the gate house to the Route 23 Northbound embankment. The wingwall is non-overflow and in good condition. | Repair cracks and spalling. |
| STRUCTURAL CRACKING | None. | |
| VERTICAL & HORIZONTAL ALIGNMENT | Good. | |
| MONOLITH JOINTS | N/A | |
| CONSTRUCTION JOINTS | Good. | |

EMBANKMENT

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| SURFACE CRACKS<br><br>N/A | | |
| UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE<br><br>N/A | | |
| SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES<br><br>N/A | | |
| VERTICAL & HORIZONTAL ALIGNMENT OF THE CREST<br><br>N/A | | |
| RIPRAP FAILURES<br><br>N/A | | |

EMBANKMENT

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM<br><br>N/A | | |
| ANY NOTICEABLE SEEPAGE<br><br>N/A | | |
| STAFF GAGE AND RECORDER<br><br>N/A | | |
| DRAINS<br><br>N/A | | |

## OUTLET WORKS

| EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| CRACKING & SPALLING OF CONCRETE SURFACES IN STILLING BASIN | Stilling basin is natural rock. Good Condition. | |
| INTAKE STRUCTURE | Submerged and not visible. Located at gate house, left side of dam. | |
| OUTLET STRUCTURE | According to Plates herein, two 48-inch steel pipes serve as the low-level outlet at the downstream side of the gate house. Ten valves and sluice gates, located in the gate house, control the flow through the pipes. All ten valves operated satisfactorily. The valve operators of all 10 valves were in good condition. The sluice gates were submerged and not visible. | |
| OUTLET FACILITIES | Seven (7) low level blow-off valves were observed along the left bank, downstream of the spillway. The valves are buried with extended stems for wrench operation. A wrench was not readily available to demonstrate operation of the valves. According to the owner, six of the valves operate satisfactorily. All 7 of the valves are connected to one (the one on the right side) of the 48-inch steel pipes. | Repair or replace the defective valve. |
| EMERGENCY GATE | None. | |

UNGATED SPILLWAY

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| CONCRETE WEIR | Longitudinal cracks and spalling were noticed in the concrete cap of the spillway. The downstream side of the spillway is stone masonry. Five of these stones were missing. Location of the missing stones were in the first two layers down from the concrete cap. Grout was also missing in some areas. The upstream side of the spillway has concrete (gunite) facing in good condition. | Repair cracks and spalling. Replace stones and re-grout where necessary. |
| APPROACH CHANNEL | The reservoir. | |
| DISCHARGE CHANNEL | Good condition. Channel has rock bottom. Discharge veers right just beyond the spillway. Some debris in channel. | Remove debris. |
| BRIDGE AND PIERS | None. | |

GATED SPILLWAY

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| CONCRETE SILL<br>N/A | | |
| APPROACH CHANNEL<br>N/A | | |
| DISCHARGE CHANNEL<br>N/A | | |
| BRIDGE AND PIERS<br>N/A | | |
| GATES & OPERATION EQUIPMENT<br>N/A | | |

INSTRUMENTATION

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| MONUMENTATION/SURVEYS<br>None. | | |
| OBSERVATION WELLS<br>None. | | |
| WEIRS<br>None | | |
| PIEZOMETERS<br>None. | | |
| OTHER<br>Water-stage recorder located on the left end of dam. | | |

RESERVOIR

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| SLOPES<br><br>Left side slopes are flat to moderate. There is a concrete crib wall on the right side (the Route 23 Southbound embankment side). It is in good condition and almost vertical. | | |
| SEDIMENTATION<br><br>None noticed. Water level was just below the spillway crest. | | |
| | | |
| | | |
| | | |

DOWNSTREAM CHANNEL

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS AND RECOMMENDATIONS |
|---|---|---|
| CONDITION (OBSTRUCTIONS, DEBRIS, ETC.) | Good condition. Channel has rock bottom from the discharge channel beyond the spillway. Further downstream, boulders are at the bottom of the channel. Some debris, including fallen trees were observed in the channel. | Remove debris and boulders. |
| SLOPES | Good condition. | |
| APPROXIMATE NUMBER OF HOMES AND POPULATION | About 600 feet from the spillway, the channel flows under a bridge that carries traffic making U-turns from both Northbound and Southbound Route 23. The flow continues downstream and crosses under Southbound Route 23 about 3,400 feet from the spillway. The first house downstream, about 2.5 miles from the spillway, is on the channel's right bank. The house is on the outskirts of Butler, population about 7,050. | |

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

| ITEM | REMARKS |
|---|---|
| PLAN OF DAM | Available at Manager's Office, City of Newark Department of Public Works, Division of Water Supply, 1294 McBride Avenue, Little Falls, NJ, 07424 |
| REGIONAL VICINITY MAP | Available-Passaic County Map and U.S.G.S. Quadrangle Sheet for Newfoundland, NJ |
| CONSTRUCTION HISTORY | No formal history exists, but it can be deduced from available plans and drawings. |
| TYPICAL SECTIONS OF DAM | Available at Manager's Office (listed above). |
| HYDROLOGIC/HYDRAULIC DATA | Daily maximum discharges, obtained from water-stage recorder, are available from U.S.G.S. 5-hour PMF is available from Department of the Army, Philadelphia District, Corps of Engineers, Philadelphia, Pennsylvania, 19106. |
| OUTLETS - PLAN | Available at Manager's Office (listed above). |
| - DETAILS | Available at Manager's Office (listed above). |
| - CONSTRAINTS | Available at Manag Office (listed above). |
| - DISCHARGE RATINGS | Not available. |
| ~~RAINFALL~~ / RESERVOIR RECORDS | Available at Manager's Office (listed above). |

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

| ITEM | REMARKS |
|---|---|
| DESIGN REPORTS | None available. |
| GEOLOGY REPORTS | Available U.S.G.S. Geologic Overlay Sheet for Passaic County and Engineering Soil Survey of New Jersey, Report No. 3--Passaic County by Rutgers University (New Brunswick, N.J.). |
| DESIGN COMPUTATIONS<br>HYDROLOGY & HYDRAULICS<br>DAM STABILITY<br>SEEPAGE STUDIES | None available. |
| MATERIALS INVESTIGATIONS<br>BORING RECORDS<br>LABORATORY<br>FIELD | None avilable. |
| POST-CONSTRUCTION SURVEYS OF DAM | None available. |
| BORROW SOURCES | Unknown. |
| SPILLWAY PLAN - SECTIONS<br>- DETAILS | Available at Manager's Office (listed above). |

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
(continued)

| ITEM | REMARKS |
|---|---|
| OPERATING EQUIPMENT PLANS AND DETAILS | Available at Manager's Office (listed above). |
| MONITORING SYSTEMS | Water level indicator plans not available. |
| MODIFICATIONS | Available at Manager's Office (listed above). See "Modifications List" below.* |
| HIGH POOL RECORDS | Daily records have been kept since 1898. |
| POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS | None known to exist. |
| PRIOR ACCIDENTS OF FAILURE OF DAM - DESCRIPTION<br>- REPORTS | None known to exist. |
| MAINTENANCE OPERATION RECORDS | None known to exist. |

* Construction Plans: Dated 1940, shows procedures for guniting upstream face of dam; dated 1944, shows revamping of screen guide system at the upstream side of tunnel under gate house and that dated 1946, indicates additional electrical equipment was installed in the gate house.

# APPENDIX B

PHOTOGRAPHS

(Taken on November 21, 1979)

Photo 1 - View from the gate house toward the right end of dam. A portion of the high dam is visible at upper right. Spillway's discharge channel, paralleling the spillway, makes a left turn near the high dam.

Photo 2 - View from the high dam looking toward the spillway, gate house and the left end of the reservoir. Traffic on Northbound Route 23 is visible beyond the gate house.

Photo 3 - View, from the high dam, toward the spillway and gate house. Note longitudinal cracks in top of high dam and spillway. Also note spalling of concrete on top of spillway.

Photo 4 - Detail of junction of high dam with spillway (top left). Note longitudinal cracks in concrete on top of high dam. The downstream channel is visible at top right.

Photo 5 - View of reservoir looking upstream. Portion of the gate house is visible on the right of photo. A portion of the spillway is visible at the lower right corner of photo.

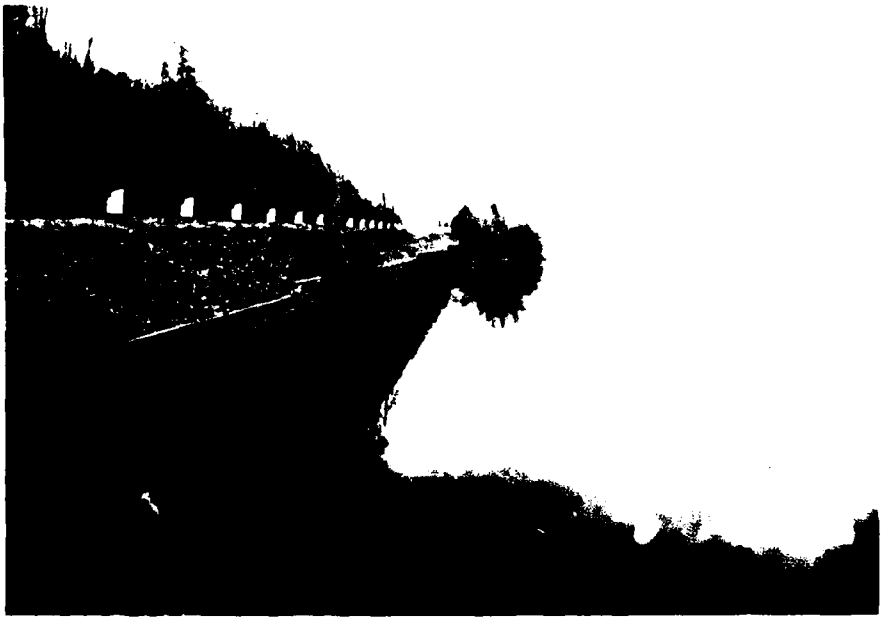


Photo 6 - View from right end of high dam looking upstream. Concrete crib wall retains embankment of Southbound Route 23, top left in photo.

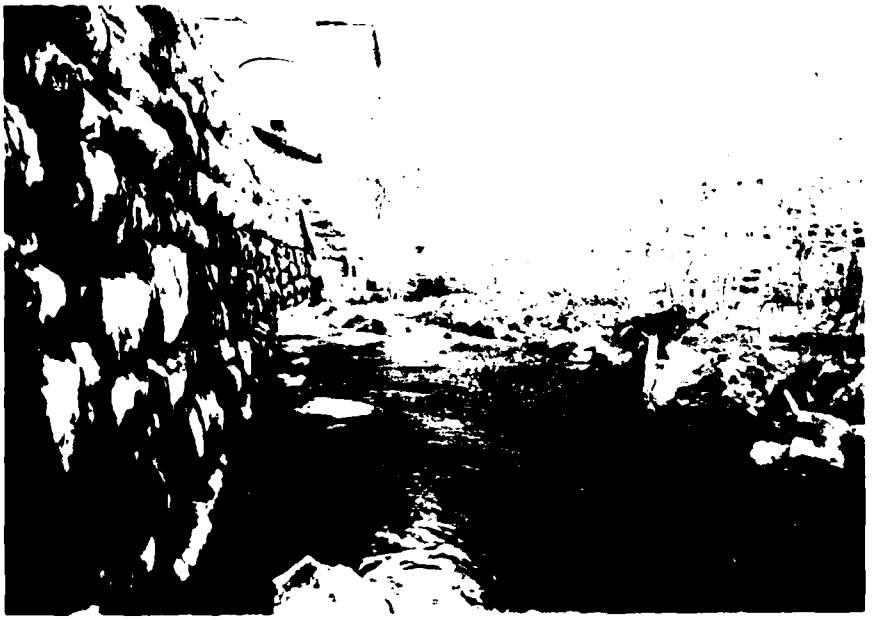
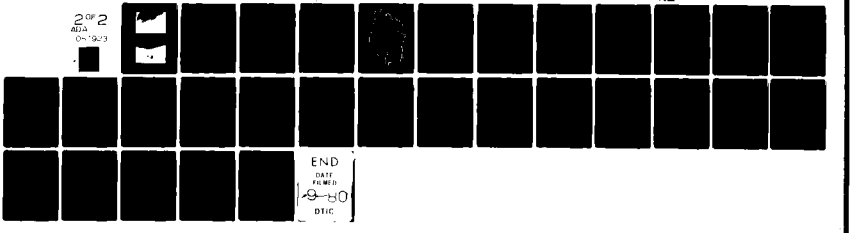


Photo 7 - View of downstream side of spillway looking toward the gate house, top left in photo. Spillway channel flow is toward viewer of photo. Portion of weathered tree trunk stands at junction of spillway and gate house. Stone wall retains embankment of Northbound Route 23, top right in photo.

AD-A087 923 NEW JERSEY DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/13
NATIONAL DAM SAFETY PROGRAM. MACOPIN RESERVOIR DAM (NJ00320), P--ETC(U)
MAY 80 J P TALERICO DACW61-79-C-0011

UNCLASSIFIED NL



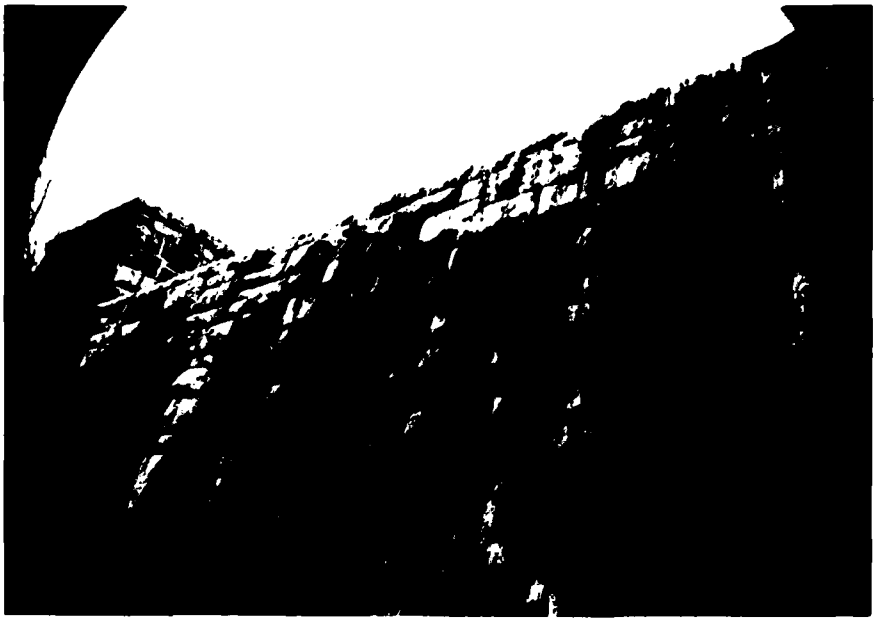


Photo 8 - Detail of downstream side of spillway showing missing stones at the top. The top of the high dam is visible at top left in photo.

Photo 9 - View of the downstream channel looking downstream. The channel flows under the bridge, center in photo. Traffic making U-turns, from both the Northbound and Southbound Rte. 23, is supported by the bridge. Northbound Rte. 23 is out of photo to viewer's left and Southbound is out of photo to viewer's right.

# APPENDIX C

## SUMMARY OF ENGINEERING DATA

# CHECK LIST
# HYDROLOGIC AND HYDRAULIC DATA
# ENGINEERING DATA

Name of Dam: Macopin Reservoir Dam

Drainage Area Characteristics: 63.7 Square miles

Elevation Top Normal Pool (Storage Capacity): 583.74 NGVD (101 acre-feet)

Elevation Top Flood Control Pool (Storage Capacity): N/A

Elevation Maximum Design Pool: 588.14 NGVD (SDF pool: 162 acre-feet)

Elevation Top Dam: 590.74 NGVD (206 acre-feet)

SPILLWAY CREST:

a. Elevation 583.74 NGVD

b. Type Stone masonry gravity with gunite facing on upstream face.

c. Width 7.0 feet

d. Length 270 feet

e. Location Spillover Entire length

f. No. and Type of Gates None

OUTLET WORKS:

a. Type 2 - 48-inch steel pipes with 7 - 16-inch blow-off pipes in the 48-inch pipe on the right.

b. Location Along the left bank downstream of the gate house.

c. Entrance Inverts 569.30 NGVD

d. Exit Inverts 569.2 NGVD

e. Emergency Drawdown Facilities 10 sluice gates, two 48-inch steel pipes with 7 - 16-inch blow-off pipes in one 48-inch pipe.

HYDROMETEOROLOGICAL GAGES:

a. Type Water-stage recorder

b. Location On left end of dam

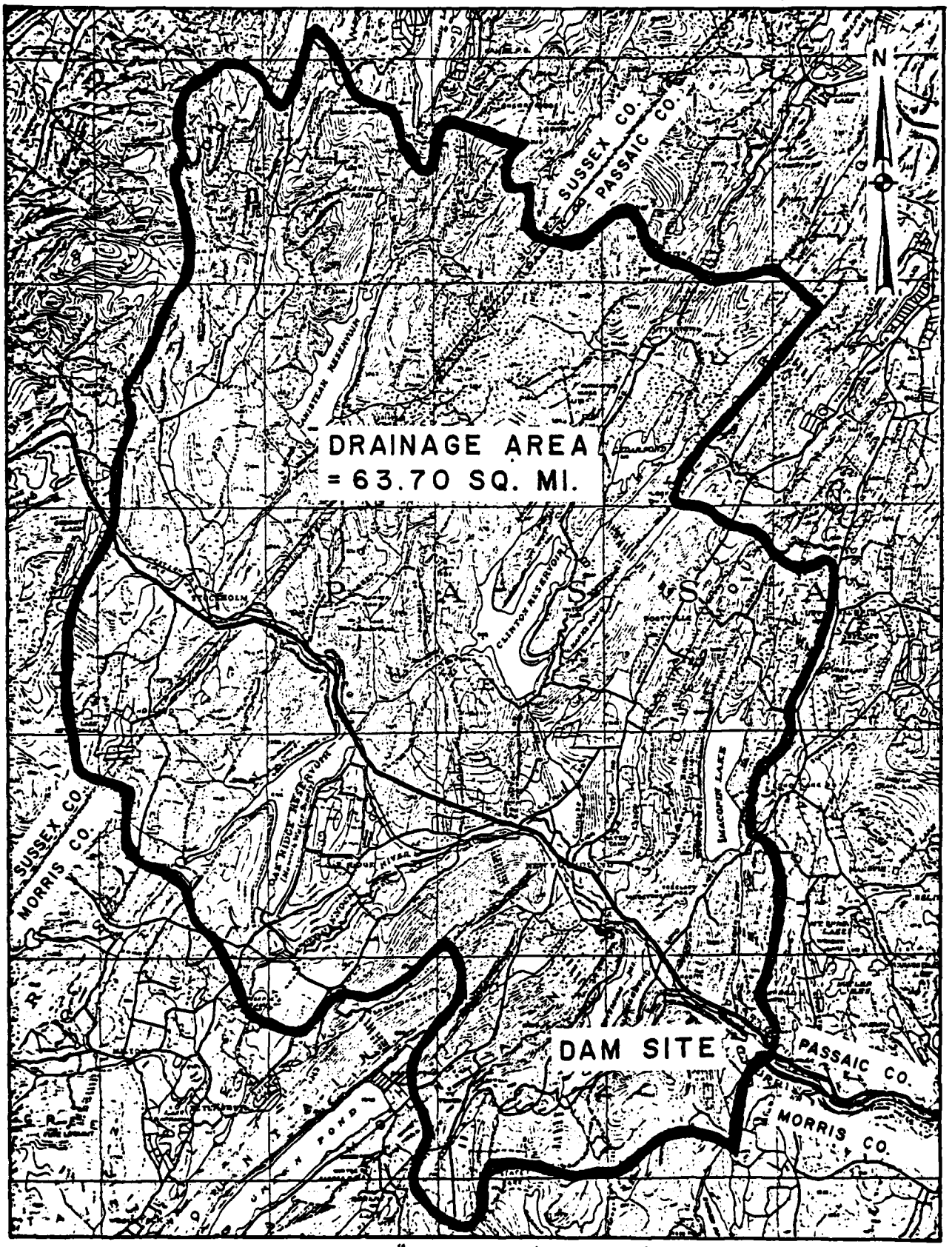
c. Records Discharge records (poor) See explanation on Water Resources Data for New Jersey

MAXIMUM NON-DAMAGING DISCHARGE: 17,602 cfs at elevation 590.74 NGVD

# APPENDIX D

# HYDROLOGIC COMPUTATIONS

PLATE 1, APPENDIX D




Scale: 3/4" = 1 Mile (Approx.)

# MACOPIN RESERVOIR DAM
# DRAINAGE BASIN

PRC Harris, Inc.
CONSULTING ENGINEERS

SUBJECT N.J. Dam Safety Prog Group XVII
Macopin Reservoir
COMPUTED BY PJK CHECKED BY C.L.G.

SHEET NO. 1 OF 5
JOB NO. 10-A83-01
DATE 2/10/

## Size Classification

| | |
|---|---|
| Main Impoundment Surface Area | 12.1 Acres |
| Average Depth of Reservoir | 8 Ft |
| Structural Height of Dam | 34 Ft |
| Size Classification | Small |

## Hazard Potential Classification

Heavily Travelled Rd and 4 House approx

| | |
|---|---|
| Hazard Potential | High |
| Recommended SDF | ½ PMF |

## Hydrologic Analysis

The COE of Philadelphia District provided 5 HR PMF Inflow Hydrograph. HEC-1 DB Comp ter program will be used for hydrologic analysis

D.A. = 63.7 Sq. mi

PRC Harris, Inc.
CONSULTING ENGINEERS

SUBJECT NJ Dam Safety Program
Macopin Reservoir
COMPUTED BY EK CHECKED BY C.L.G.

SHEET NO. 2 OF 5
JOB NO. 10-A83-01
DATE 2/10/80

DAM SAFETY PROGRAM-PHASE I
MACOPIN RESERVOIR 5 HR. PMF INFLOW HYDROGRAPH

| Period | Time (Hr) | Inflow (cfs) |
|---|---|---|
| 1 | 5 | 120 |
| 2 | 10 | 220 |
| 3 | 15 | 390 |
| 4 | 20 | 550 |
| 5 | 25 | 800 |
| 6 | 30 | 1250 |
| 7 | 35 | 2020 |
| 8 | 40 | 7670 |
| 9 | 45 | 17590 |
| 10 | 50 | 16120 |
| 11 | 55 | 13800 |
| 12 | 60 | 12100 |
| 13 | 65 | 9600 |
| 14 | 70 | 8100 |
| 15 | 75 | 6900 |
| 16 | 80 | 6000 |
| 17 | 85 | 5200 |
| 18 | 90 | 4600 |
| 19 | 95 | 4000 |
| 20 | 100 | 3500 |
| 21 | 105 | 3100 |
| 22 | 110 | 2700 |
| 23 | 115 | 2350 |
| 24 | 120 | 2050 |
| 25 | 125 | 1700 |
| 26 | 130 | 1500 |
| 27 | 135 | 1200 |
| 28 | 140 | 1000 |
| 29 | 145 | 800 |
| 30 | 150 | 600 |
| 31 | 155 | 400 |
| 32 | 160 | 300 |
| 33 | 165 | 200 |
| 34 | 170 | 120 |
| 35 | 175 | 90 |
| 36 | 180 | 0 |

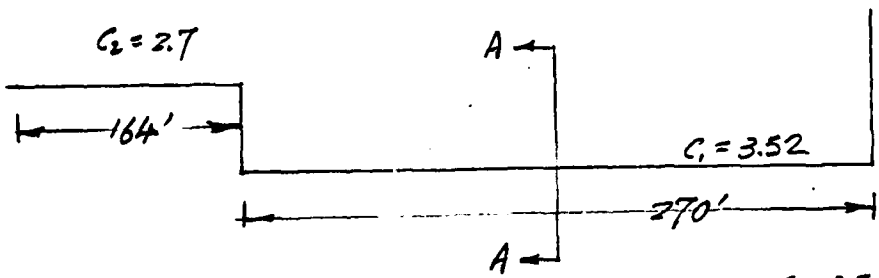
Supplied by COE, Philadephia District

## ELEVATION - AREA - CAPACITY RELATIONSHIP

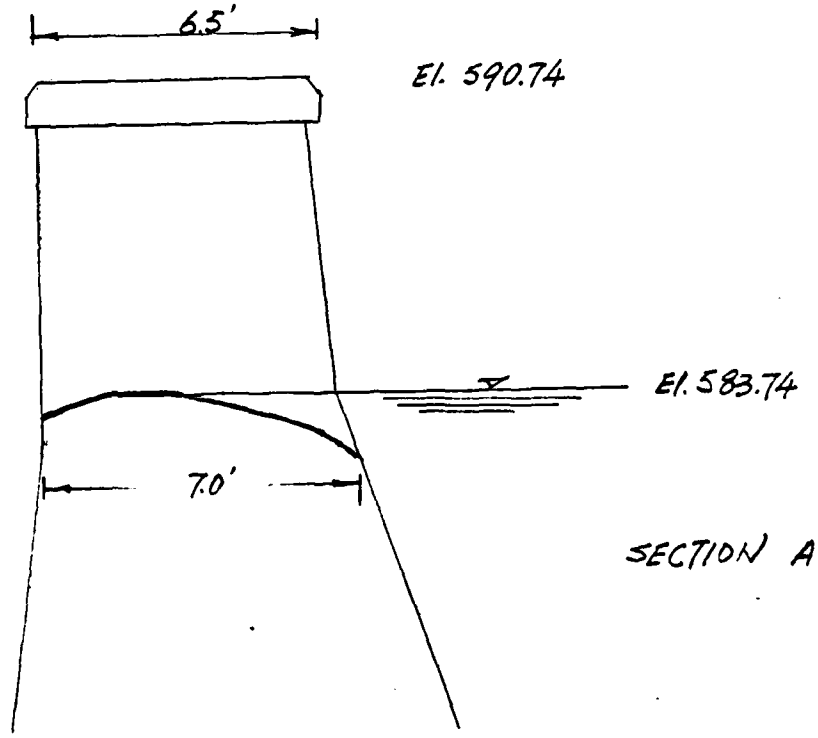
| Elevation (ft) | 559.2* | 583.55 | 600 | 620 | 640 |
|---|---|---|---|---|---|
| Surface Area (Ac.) | 0 | 12.1 | 27.6 | 58.8 | 84.5 |

* Ref. HEC-1 DB, "A", S = 98.2 Ac-ft $\Delta E = \frac{35}{A} = \frac{3 \times 98.2}{12.1} = 24.35'$, 583.55 - 24.35 = 559.2

HEC-1 DB program will develope storage - capacity relationship from the surface areas & elevations data.




$C_1 = 3.5$ table 5-13 · King &
$C_2 = 2.7$ table 5-3 · Brater



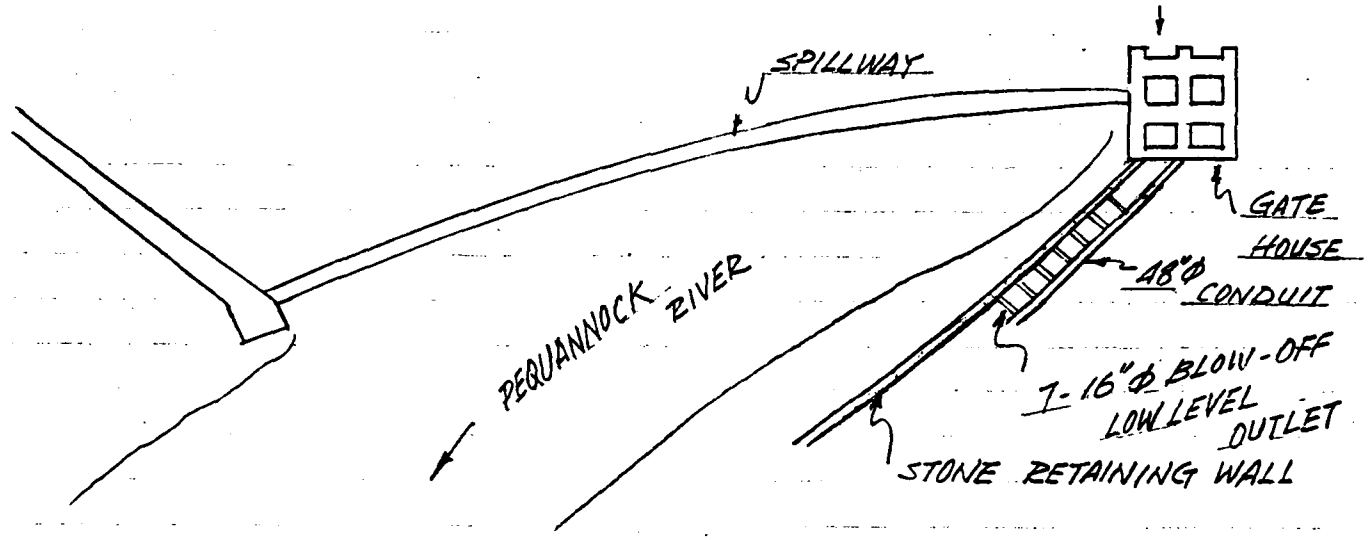

SECTION A-A

**PRC Harris, Inc.**
CONSULTING ENGINEERS

SUBJECT NJ DAM SAFETY INSPECTION
MACOPIN RESERVOIR DAM
COMPUTED BY C.L.C. CHECKED BY R-K

SHEET NO. 4 OF 5
JOB NO. 10-A83-01
DATE 3/11/80 4/11/80

## DRAWDOWN TIME COMPUTATION




El. 583.74

$\epsilon = .00085$

36" $\frac{\epsilon}{D} = .000283$ $f_1 = .0145$

48" $\frac{\epsilon}{D} = .000018$ $f_2 = .0136$

El. 569.20

16" $\frac{\epsilon}{D} = .000638$ $f_3 = .017$

7-16"ϕ C.I.P.

**LOSSES:**

| | | $K_{@16"}$ |
|---|---|---|
| Gate House | Entrance | 0.1 |
| | Sluice gate | 0.1 |
| | Bar Screen | 0.28 |
| | Contraction | 0.17 |
| | Sluice gate | 0.10 |
| | 36"ϕ pipe $\frac{fL}{D} = .0145(5)(3)^{-1}$ | 0.02 |
| | expansion | 0.17 |
| | contraction | 0.10 |
| | 48"ϕ pipe $\frac{fL}{D} = .0136(40')(4)^{-1}$ | 0.02 |
| | 45° Bends | 0.05 |

PRC Harris, Inc.
CONSULTING ENGINEERS

SUBJECT N.J. DAM SAFETY INSPECTION SHEET NO. 5 OF 5
MACOPIN RESERVOIR DAM JOB NO. 10-A82-01
COMPUTED BY C.L.C. CHECKED BY R.K. DATE 2/14/80, 4/12/80

## DRAWDOWN TIME COMPUTATION (CONTINUED)

LOSSES (CONTINUED):

| | | |
|---|---|---|
| Gate valve (Wide Open) | | 0.2 |
| 16"Φ pipe | $\frac{fL}{D} = .017(4')(1.33')^{-1}$ | 0.05 |
| outlet loss | | 1.0 |
| | | $\Sigma k = 2.36$ |

$$H = \Sigma k \frac{V^2}{2g} = 2.36 \frac{V^2}{2g}$$

$$\therefore V = 5.22\sqrt{h}$$

$$q = VA = (5.22\sqrt{h})\left(\frac{\pi}{4}1.33^2\right) = 7.25\sqrt{h}$$

$$Q = \Sigma q = 7q = 7(7.25\sqrt{h}) = 50.76\sqrt{h}$$

| Res. EL. | Area Ac | AVG. AREA | Vol. | AVG. RES. EL. | Q $50.76\sqrt{h}$ | DRAW DOWN TIME $\frac{24 Vol.}{1.98 Q}$ | Cul. time (HRS.) | DRAIN DOWN TIME w/inflow $1274 \frac{t}{Q}$ | Cul. time (HRS.) |
|---|---|---|---|---|---|---|---|---|---|
| 583.74 | 12.1 | | | | | | | | |
| | | 10.4 | 38.9 | 581.9 | 180.2 | 2.62 | 2.62 | 1.85 | 4.47 |
| 580 | 8.7 | | | | | | | | |
| | | 6.85 | 34.3 | 577.5 | 145.4 | 2.86 | 5.48 | 2.51 | 9.84 |
| 575 | 5.0 | | | | | | | | |
| | | 3.5 | 20.3 | 572.1 | 84.9 | 2.90 | 8.38 | — | 12.7 |
| 569.3 | 2.0 | | | | | | | | |
| 559.2 | 0 | | | | | | | | |

A) Time of complete drawdown with no inflow = 8.38 HRS.

B) Time of complete drawdon with inflow (127.4 cfs) = 12.7 HRS

$$A_2 = \frac{A_1}{\left(\frac{h}{h_T}+1\right)^2}, \text{ where } A_1 = 12.1 \text{ Ac}, h+h_T = 24.54'$$

```
A1                N J DAM SAFETY INSPECTION PROGRAM----GROUP XVII  10A8301
A2                N J 00320 MACOPIN RESERVOIR, PASSAIC COUNTY, NJ
A3                5HR. PMF ROUTING,PRC-HARRIS INC., WOODBRIDGE, N J
B       36        5                                          0       0       4
B1       5
J        1        5        1
J1      .5       .4       .3       .2       .1
K        0   LAKE                        0       0       1
K1                INFLOW HYDROGRAPH THROUHG MACOPIN RESERVOIR
M       -1
N      120      220      390      550      800     1250     2020     7670    17590    16120
N    13800    12100     9600     8100     6900     6000     5200     4600     4000     3500
N     3100     2700     2350     2050     1700     1500     1200     1000      800      600
N      400      300      200      120       90        0
K        1   DAM                         0       0       1
K1                ROUTING DISCHARGE THROUGH DAM
Y                                    1       1
Y1       1                                          -583.74                 0
$A       0     12.1     27.6     58.8     84.5
$E   559.2   583.55      600      620      640
$$583.74      270     3.52      1.5
$D590.74      2.7      1.5      164
K       99
A
A
A
A
#
```

N J DAM SAFETY INSPECTION PROGRAM---GROUP XVII 10A8301
N J 00320 MACOPIN RESERVOIR, PASSAIC COUNTY, NJ
5HR, PMF ROUTING,PRC-HARRIS INC., WOODBRIDGE, N J

JOB SPECIFICATION

| NQ | NHR | NMIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
|---|---|---|---|---|---|---|---|---|---|
| 36 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 |
| | | | JOPER | NWT | LROPT | TRACE | | | |
| | | | 5 | 0 | 0 | 0 | | | |

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1
RTIOS= .50 .40 .30 .20 .10

******** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH THROUHG MACOPIN RESERVOIR

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| LAKE | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| -1 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.000 | 0 | 0 | 0 |

## HYDROGRAPH ROUTING

### ROUTING DISCHARGE THROUGH DAM

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| DAM | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | LSTR |
|---|---|---|---|---|---|---|---|
| 0.0 | 0.000 | 0.00 | 1 | 1 | 0 | 0 | 0 |

| NSTPS | NSTDL | LAG | AMSKK | X | TSK | STORA | ISPRAT |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0.000 | 0.000 | 0.000 | -584. | 0 |

| | | | | | |
|---|---|---|---|---|---|
| SURFACE AREA= | 0. | 12. | 28. | 59. | 85. |
| CAPACITY= | 0. | 98. | 416. | 1261. | 2686. |
| ELEVATION= | 559. | 584. | 600. | 620. | 640. |

| CREL | SPWID | COQW | EXPW | ELEVL | COQL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 583.7 | 270.0 | 3.5 | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COQD | EXPD | DAMWID |
|---|---|---|---|
| 590.7 | 2.7 | 1.5 | 164. |

PEAK OUTFLOW IS 8763. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 7008. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 5253. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 3500. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 1746. AT TIME 45.00 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

| OPERATION | STATION | AREA | PLAN | RATIOS APPLIED TO FLOWS RATIO 1 .50 | RATIO 2 .40 | RATIO 3 .30 | RATIO 4 .20 | RATIO 5 .10 |
|---|---|---|---|---|---|---|---|---|
| HYDROGRAPH AT | LAKE | 0.00 | 1 | 8795. | 7036. | 5277. | 3518. | 1759. |
| | | ( 0.00) | | ( 249.05)( | 199.24)( | 149.43)( | 99.62)( | 49.81)( |
| ROUTED TO | DAM | 0.00 | 1 | 8763. | 7008. | 5253. | 3500. | 1746. |
| | | ( 0.00) | | ( 248.13)( | 198.44)( | 148.76)( | 99.10)( | 49.43)( |

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 583.74 | 583.74 | 590.74 |
| STORAGE | 101. | 101. | 206. |
| OUTFLOW | 0. | 0. | 17602. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| .50 | 588.14 | 0.00 | 162. | 8763. | 0.00 | 45.00 | 0.00 |
| .40 | 587.53 | 0.00 | 153. | 7008. | 0.00 | 45.00 | 0.00 |
| .30 | 586.87 | 0.00 | 143. | 5253. | 0.00 | 45.00 | 0.00 |
| .20 | 586.12 | 0.00 | 132. | 3500. | 0.00 | 45.00 | 0.00 |
| .10 | 585.24 | 0.00 | 120. | 1746. | 0.00 | 45.00 | 0.00 |

```
1**********
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  26 FEB 79
 **********
 10.48.26.JOB(CM277000,T200,I0400,L20,P[illegible]
 10.48.27.ACCOUNT(C0474E,)       10A8301
 10.48.27.
 10.48.27.CID(EUGENE KOO)
 10.48.27.
 10.48.27.GET,SYSIN=DMOCR.
 10.48.27.SYSCALL(HEC1DAM/NOECHO)
 10.48.28.*****************************************
 10.48.28 *HEC1DAM          22 AUG 79
```

# APPENDIX E

# STABILITY CALCULATIONS

MACOPIN RESERVOIR DAM

ASSUMPTIONS MADE IN STABILITY ANALYSES

A static stability analyses were performed at the high dam and spillway sections based on the following assumptions:

a. The maximum flood will be at elevation 588.14

b. Hydraulic heads based on the above elevation and the foundation elevation will be 36.4 ft. for the high dam and 24.4 ft. at the spillway.

c. Full uplift pressure is developed.

d. Earth material has values of 0.333 and 3.0 for the active and passive pressures.

e. The masonry has a unit weight of 150 p.c.f.

f. Where the foundation is rock (spillway) the friction factor is 0.7; where soil or rock fill (high dam) the friction factor is 0.6.

PRC Harris, Inc.
CONSULTING ENGINEERS

SUBJECT Passaic River Basin Flood Control Study - High Hazard Dams and Spillways SHEET NO. 1 OF 1
COMPUTED BY [illegible] JOB NO. [illegible]
CHECKED BY [illegible] DATE [illegible]

| Section | Resultant (from toe) No Uplift | Resultant (from toe) Uplift | Sliding F.S. No Uplift | Sliding F.S. Uplift |
|---|---|---|---|---|
| High Dam | 8.0 = 8.0 | 4.33 < 8.0 | 2.17 | 1.54 |
| Spillway | 4.13 < 4.94 $\frac{1}{3}$ > 3.7 $\frac{1}{2}$ * | 1.40 < 4.94 $\frac{1}{3}$ < 3.70 $\frac{1}{2}$ | 1.50 | 1.00 |

* Note: The spillway appears to be on rock. Some investigators accept the resultant within the middle half as shown above.

1903 flood

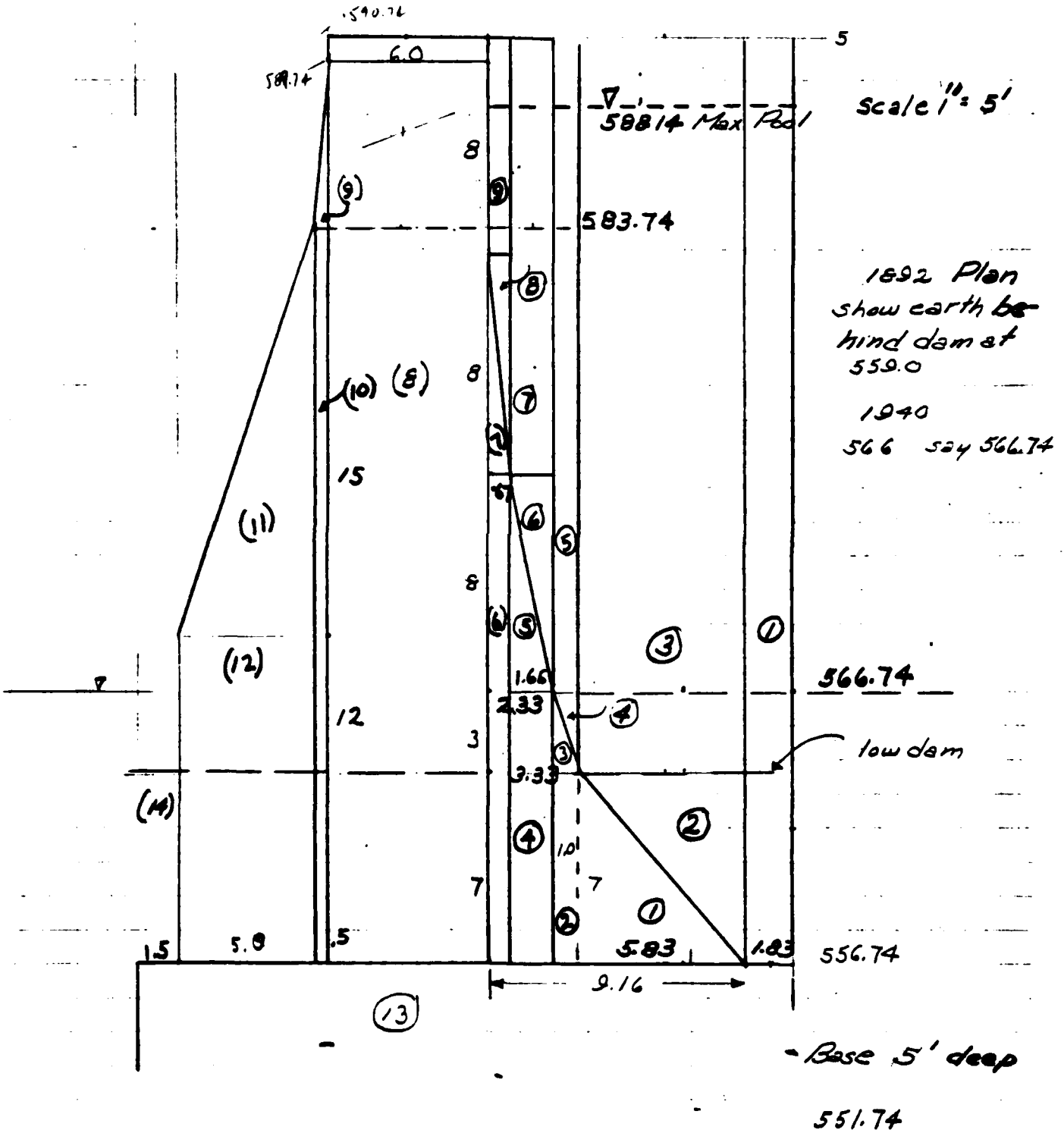
| | | | | |
|---|---|---|---|---|
| High Dam | 8.21 > 8.0 | 4.79 < 8.0 | 2.26 | 1.61 |
| Spillway | 4.16 < 4.94 > 3.70 | 1.37 < 8.0 | 1.51 | 1.00 |

**FREDERIC R. HARRIS, INC.**
CONSULTING ENGINEERS

SUBJECT Macopin Reservoir
High Dam - Water at top
COMPUTED BY HK CHECKED BY JP

SHEET NO. 1 OF 14
JOB NO. 12A23.01
DATE Feb 19, 1960

N.J. Dams - GROUP XVII - Phase I Safety Inspection.



FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT Macopin Reservoir
High Dam - Water at top
COMPUTED BY L.K. CHECKED BY J.P.

SHEET NO. 2 OF 14
JOB NO. 10A630/
DATE Feb 13 1962

Water

| Slice | W | ℓ | $M_A$ |
|---|---|---|---|
| 1 | 3862.53<br>1.83X34X62.4 | 22.17 (23.085)<br>(24-1.83)+ 1.83/2 | 89628.2 |
| 2 | 1273.27<br>5.63/2 X7X62.4 | 16.34 (20.23) 3.89<br>(24-7.66)+ 5.63X2/3 | 25758.3 |
| 3 | 9822.38<br>5.93X27X62.4 | (19.26)<br>(24-16.34 7.66)+ 5.63/2 | 189179.1 |
| 4 | 93.6<br>1X 3/2 X62.4 | (16.01)<br>(24-15.34 8.66)+ 2X1/3 | 1496.5 |
| 5 | 1497.6<br>24X1X62.4 | 15.34 (15.84)<br>(24-8.66)+ 1/2 | 23722 |
| 6 | 414.3<br>1.66/2 X8X62.4 | (14.79) 1.11<br>(24-13.68 10.32)+ 2X1.66/3 | 6128 |
| 7 | 1657.3<br>1.66X16X62.4 | (14.51)<br>(24-13.68 10.32)+ 1.66/2 | 24048.1 |
| 8 | 164.7<br>.67/2 X8X62.4 | (13.45)<br>(24-11.)+ 2X67/3 | 2215.7 |
| 9 | 334.5<br>.67X8X62.4 | (13.33)<br>(24-11)+ .67/2 | 4455.4 |
| | 19140.2 | | 366636.3 |

Masonry

| | | | |
|---|---|---|---|
| 1 | 3060.8<br>5.63/2 X7X150 | 18.26 (18.26)<br>16.34 (19.26)<br>(24-7.66)+ 5.63/2 3 | 55960.6<br>~~38950.~~ |
| 2 | 1050<br>7X1X150 | 15.34 (15.65)<br>(24-8.66)+ 1/2 | 16442.5 |
| 3 | 225<br>1X 3/2 X150 | (15.67)<br>15.34 + 1/3 | 3525.6 |
| 4 | 2490<br>10X1.66X150 | (14.51)<br>(24-13.68 10.32)+ 1.66/2 | 36129.9 |
| 5 | 996<br>1.66/2 X8X150 | (14.23)<br>(24-13.68 10.32)+ 1.66/3 | 14173.1 |
| 6 | 1809<br>16X.67X150 | (13.33)<br>(24-11)+ .67/2 | 24114.0 |
| | 9630.8 | | ~~153535.3~~ |

FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT Mecopin Reservoir
High Dam - Water at top
COMPUTED BY HS CHECKED BY JP

SHEET NO. 3 OF 14
JOB NO. 10A8301
DATE Feb 13, 1960

| | | | |
|---|---|---|---|
| | 9630.8 | | |
| 7 | $\frac{.67}{2} \times 8 \times 150$ = 399.6 | $(24-11) + \frac{.67}{3}$ = 13.22 | 5282.7 |
| 8 | $34 \times 6 \times 150$ = 30,600 | $7 + \frac{6}{2}$ = 10 | 306000 |
| 9 | $6 \times \frac{.5}{2} \times 150$ = 225 | $6.5 + \frac{.5 \times 2}{3}$ | 1536.8 |
| 10 | $27 \times .5 \times 150$ = 2025 | $6.5 + \frac{.5}{2}$ | 13668.8 |
| 11 | $\frac{5}{2} \times 15 \times 150$ = 5625 | $1.5 + \frac{2 \times 5}{3}$ = 3.33 | 27168.8 |
| 12 | $5.0 \times 12 \times 150$ = 9000 | $1.5 + \frac{5.0}{2}$ | 36000 |
| | 47874.6 | | |
| | 57505.4 | | ~~150515.6~~ 389657.1 ~~153535.3~~ ~~543192.4~~ 540203 |

Base of Dam

| | | | |
|---|---|---|---|
| 13 | $5 \times 24 \times 150$ = 18000 | 12 | 216000 |

Earth Behind Dam

| | | | |
|---|---|---|---|
| "1" | $1.83 \times 10 \times 60$ = 1098 | $22.17 + \frac{1.83}{2}$ = 23.09 | 25347.3 |
| 2 | $\frac{5.83}{2} \times 7 \times 60$ = 1224.3 | $16.34 + \frac{5.83 \times 2}{3}$ = 20.23 | 24767.6 |
| "3" | $5.83 \times 3 \times 60$ = 1049.4 | $16.34 + \frac{5.83}{2}$ = 19.26 | 20211.4 |
| 4 | $1 \times \frac{3}{2} \times 60$ = 90 | $15.34 + \frac{2 \times 1}{3}$ = 16.01 | 1440.9 |
| | 3461.7 | | 71767.2 |

Earth in front of Dam

| | | | |
|---|---|---|---|
| 14 | $1.5 \times 12 \times 60$ = 1080 | $\frac{1.5}{2}$ | 810 |

Water up to 566.74

| | | | |
|---|---|---|---|
| "14" | $1.5 \times 12 \times 624$ = 1123.2 | $\frac{1.5}{2}$ | 842.4 |

FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT Macopin Reservoir
High Dam - Water at top
COMPUTED BY HK CHECKED BY JP

SHEET No. 4 OF 14
JOB No. 10AE3.01
DATE Feb 20, 1960

Summation

| | | |
|---|---|---|
| Water | 19140.2 | 366,636.3 |
| Concrete | 57505.4 | 543,192.4 |
| | 18000 | 216,000 |
| Earth$_b$ | 3461.7 | 71,767.2 |
| Earth$_f$ | 1080 | 810.0 |
| Water$_f$ | 1123.2 | 842.4 |
| | 100310.5 ↓ | ~~1,099,248.3~~ 1,196,264.4 |

$\bar{x} = \frac{1199248.3}{100310.5} = 11.96$ from toe

Overturning Forces

Water Forces upstream

47455.2

$\frac{1}{2} \times 62.4 \times 39^2$ $\frac{39}{3}$ 616917.6

Earth Forces upstream

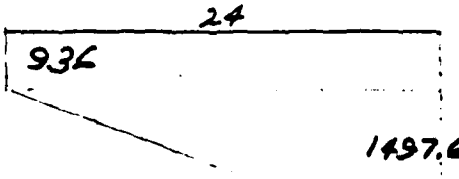
2250

$\frac{1}{2} \times 60 \times 15 \times \frac{2}{3}$ $\frac{15}{3}$ 11,250.0

Uplift

$62.4 \times 39 = 2433.6$

$62.4 \times 15 = 936$




2433.6
936.0
1497.6 1497.6

Pressure

22464
$936 \times 24$
11971.2
$\frac{1497.6 \times 24}{2}$
40435.2 ↑

$\frac{24}{2}$

$\frac{24 \times 2}{3}$

269568
287539.2
557107.2
1196264.4

FREDERIC R. HARRIS, INC.
CONSULTING ENGINEERS

SUBJECT Macopin Reservoir
High Dam - Water at top
COMPUTED BY HK CHECKED BY JP

SHEET No. 5 OF 14
JOB No. 10.A63.01
DATE Feb 29, 1980

Righting Forces

Water Forces Downstream
assumed at 566.7a

7020

$\frac{1}{2} \times 62.4 \times 15^2 \quad \frac{15}{3} \qquad 35{,}100$

Earth Forces Downstream
full Passive

20,250 Kp

$\frac{1}{2} \times 60 \times 15^2 \times 3.0 \quad \frac{15}{3} \qquad 101{,}250$

Note: Hydraulic Calculation indicate the water will not reach dam top but elevation 566.14. The calculations will be revised to account for this.

PRC Harris, Inc.
CONSULTING ENGINEERS

SUBJECT Macopin Reservoir
High Dam - Water at 566.14
COMPUTED BY HK CHECKED BY JP

SHEET NO. 6 OF 17
JOB NO. 10A.63.01
DATE April 15, 1950

Sheets 1 to 5 show calculations for water at top of high dam. Water reaches 566.14

590.74 Elev. High Dam
566.14 Max. Pool
2.60'

Water deduction from 590.74 to 566.14 or 2.60

| | | |
|---|---|---|
| $-2.6 \times 11.2 \times 62.4$ (1817.1) | 18.6 | -33797.8 |
| Sheet 4 +100310.5 | | +1,196264.4 |
| 98493.4 | | 1,162,466.6 |

$$\bar{x} = \frac{1,162,466.6}{98493.4} = 11.8$$

Overturning Moments

| | | |
|---|---|---|
| Water 41338.6<br>$\frac{1}{2} \times 62.4 \times 36.4^2$ | $\frac{36.4}{3}$ | 501576.9 |
| Earth Forces Upstream 2250<br>$\frac{1}{2} \times 60 \times 15^2 \times \frac{1}{3}$<br>43588.8 | $\frac{15}{3}$ | 11250 |
| | | 512826.9 |

Righting Moments

| | |
|---|---|
| 98493.4 | 1,162,466.6 |
| Sheet 5 7020 | 35,100 |
| " 20250 | 101250 |
| | 1298816.6 |

PRC Harris, Inc.
CONSULTING ENGINEERS

SUBJECT Macapin Reservoir
High Dam Water at 566.14
COMPUTED BY HK CHECKED BY JP

SHEET NO. 7 OF 14
JOB NO. 10A6301
DATE April 15, 1980

Assume No Uplift

$$X = \frac{1296616.6 - 512826.9}{98493.4} = 8.0 = \frac{24}{3} = 8 \text{ at middle } \frac{1}{3}$$

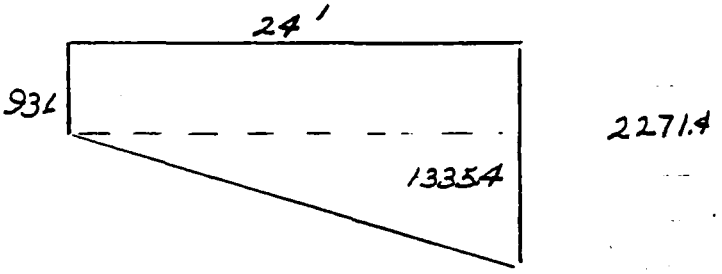
f for earth or rockfill

Sliding $\frac{98493.4 \times .6 + 20250}{43588.6 - 7020} = 2.17$

W, Ko, Wp

Consider Uplift

$62.4 \times 36.4 = 2271.4$
$62.4 \times 15 = 936$




Pressure

22464
$936 \times 24$
16024.8
$\frac{1335.4}{2} \times 24$
38488.8

$\frac{24}{2}$

$\frac{2 \times 24}{3}$

269565

$\frac{256396.8}{525964.8}$

The Uplift Forces are overturning forces

Sheet 6 Overturning Moments

43588.6
38488.8
96493.4

512826.9
525964.8
1038791.7

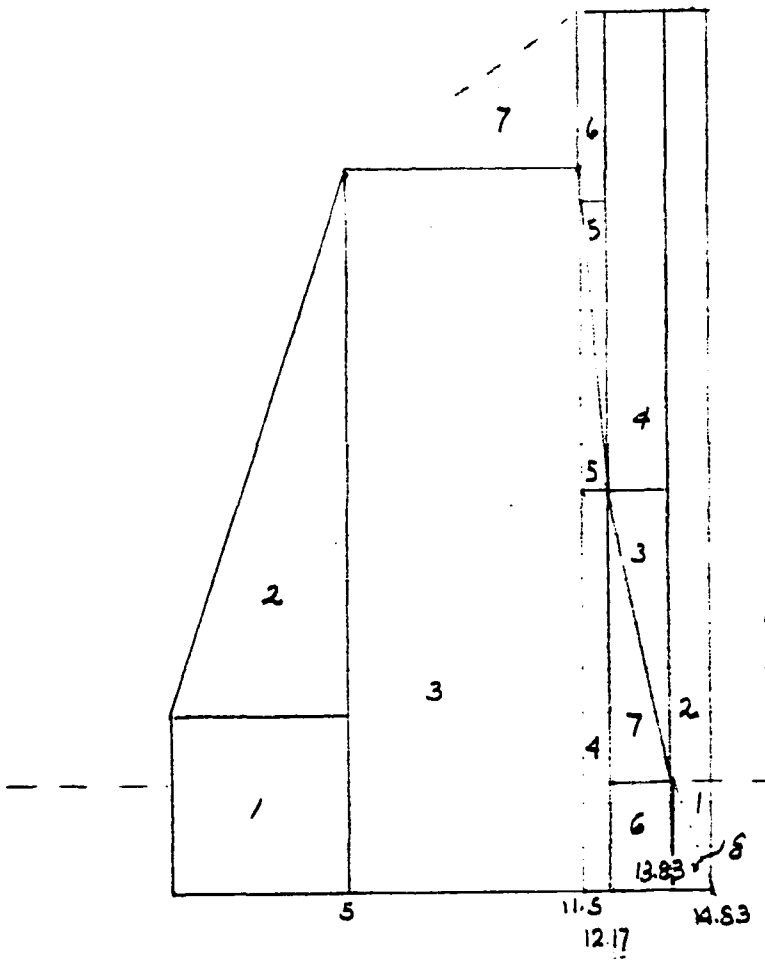
$$X = \frac{1296616.6 - 1038791.7}{96493.4 - 38488.8} = 4.33 \text{ from toe} < 8$$

$$\text{Sliding} = \frac{(98493.4 - 36488.8) .6 + 20250}{43566.6 - 7020} = 1.54$$

**PRC Harris, Inc.**
CONSULTING ENGINEERS

SUBJECT Macopin Reservoir
Spillway - Water to 568.14
COMPUTED BY HK CHECKED BY JP

SHEET NO. 8 OF 14
JOB NO. 10A8301
DATE April 15, 1980




The embedment appears to shallow

| | Masonry | W | | H |
|---|---|---|---|---|
| 1 | 5x5x150 | 3750 | $\frac{5}{2}$ | 9375 |
| 2 | $\frac{5}{2}$ x 15 x 150 | 5625 | $\frac{2 \times 5}{3}$ | 18750 |
| 3 | 20 x 6.5 x 150 | 19500 | $5 + \frac{6.5}{2}$ | 160875 |
| 4 | .67 x 11 x 150 | 1105.5 | $11.5 + \frac{.67}{2}$ | 13083.6 |
| 5 | $\frac{.67}{2}$ x 6 x 150 | 402 | $11.5 + \frac{.67}{3}$ | 4755.7 |
| 6 | 1.66 x 3 x 150 | 751.5 | $12.17 + \frac{1.66}{2}$ | 9769.5 |
| 7 | $\frac{1.66 \times 8 \times 150}{2}$ | 996 | $12.17 + \frac{1.66}{3}$ | 12672.4 |
| | | | 12.72 | |

PRC Harris, Inc.
CONSULTING ENGINEERS

SUBJECT Macopin Reservoir
Spillway - Water to 586.1±
COMPUTED BY LK CHECKED BY JP

SHEET No. 9 OF 14
JOB No. 1AA83.01
DATE April 15, 1982

| | | | | |
|---|---|---|---|---|
| 8 | $\frac{1}{2}$ X 3 X 150 | 225 | 13.83 + $\frac{1}{3}$ | 3187 |
| | | 32355 | | 2324672 |

Water

| | | | | |
|---|---|---|---|---|
| 1 | $\frac{1}{2}$ X 3 X 62.4 | 93.6 | 13.83 + $\frac{2 \times 1}{3}$ | 1357.2 |
| 2 | 1 X 21.4 X 62.4 | 1335.4 | 13.83 + $\frac{1}{2}$ | 19135.7 |
| 3 | $\frac{1.66 \times 8 \times 62.4}{2}$ | 414.3 | 12.17 + $\frac{2 \times 1.66}{3}$ | 5506.5 |
| 4 | 1.66 X 13.4 X 62.4 | 1388.0 | 12.17 + $\frac{1.66}{2}$ | 18044 |
| 5 | $\frac{.67}{2}$ X 6 X 62.4 | 167.2 | 11.5 + $\frac{2 \times .67}{3}$ | 1997.5 |
| 6 | 5.4 X .67 X 62.4 | 225.8 | 11.5 + $\frac{.67}{2}$ | 2670.8 |
| 7 | $\frac{4.4}{2}$ X 6.5 X 62.4 | 892.3 | 5 + $\frac{2 \times 6.5}{3}$ | 8328.1 |
| | | 4516.6 | | 57033.8 |
| Σ | | 36871.6 | | 269501 |

Overturning

| | | | |
|---|---|---|---|
| $\frac{1}{2}$ X $20^2$ X 62.4 | 12480 | $\frac{2C}{3}$ | 83200 |
| 4.4 X 62.4 X 20 | 5491.2 | $\frac{2C}{2}$ | 54912 |
| Earth $\frac{1}{2}$ X 60 X $3^2$ X $\frac{1}{3}$ | 90 | $\frac{3}{3}$ | 90 |
| | 18061.2 | | 138202 |

Righting

| | | | |
|---|---|---|---|
| | 36871.6 ↓ | | 269501 |
| → | $\frac{1}{2}$ X $3^2$ X 62.4 | 280.8 | $\frac{3}{3}$ | 280.8 |

PRC Harris, Inc.
CONSULTING ENGINEERS

SUBJECT Macopin Reservoir
Spillway-Water to 886.14
COMPUTED BY H.K. CHECKED BY J.P.

SHEET NO. 10 OF 14
JOB NO. 10A8301
DATE April 15, 1980

| | | | |
|---|---|---|---|
| $\frac{1}{2} \times 3^2 \times 60 \times 3$ | 810 | $\frac{3}{3}$ | 810 |
| $\Sigma$ | 36871.6 | | 290591.8 |

Assume No Uplift

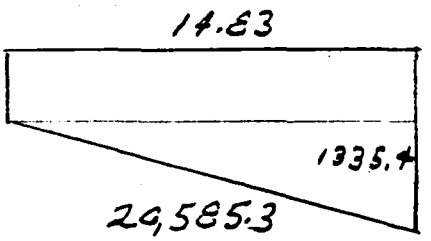
$$x = \frac{290591.8 - 138202}{36871.6} = 4.13 \quad \frac{14.83}{3} = 4.94$$

On rock middle half $\frac{14.83}{4} = 3.70$

Sliding $\frac{36871.6 \times .7 + 810}{18061.2 - 260.8} = 1.50$ (Rock Passive)

Consider Uplift

$62.4 \times 3 = 187.2$
$62.4 \times 24.4 = 1522.6$




| | | | |
|---|---|---|---|
| 2776.2 | | | |
| $187.2 \times 14.83 =$ | | $\frac{14.83}{2}$ | 29,585.3 |
| 2902 | | | |
| $\frac{1335.4}{2} \times 14.83$ | | $\frac{2 \times 14.83}{3}$ | 97,697.7 |
| 12678.2 ↑ | | | 118483 O.M |

2 O.M.

138202
118483
256685

$$x = \frac{290591.8 - 256665}{36871.6 - 12678.2} = 1.40 < 3.7 < 4.94$$

Sliding $\frac{(36871.6 - 12678.2) .7 + 810}{18061.2 - 260.6} = 1.00$

PRC Harris, Inc.
CONSULTING ENGINEERS

SUBJECT Maggin Reservoir
High Dam - Water to 597.4
COMPUTED BY HK CHECKED BY JP

SHEET NO. 11 OF 14
JOB NO. 10A8301
DATE April 15, 1982

1903 Flood
Dam calculations max flood 593.14 } 0.7
1903 flood 597.40 }
base of dam 557.74
35.7

Righting Forces

Water reduction 590.74 to 557.4 = 3.3 ft

3.3 X 11.2 X 62.4 — 2306.3 — 19.6 — 42897.2

Sheet 4 100310.5 — 1196264.4
Σ 98004.2 — 1153367.2

$\bar{x} = \frac{1153367.2}{98004.2} = 11.77$

Add additional Righting Forces

Sheet 5 7020 — 35.100
" 20250 — 101250
1269717.2

Overturning
39764.1
$\frac{1}{2} X 62.4 X 35.7^2$ — $\frac{35.7}{3}$ — 473192.6

Earth Forces
2250
$\frac{1}{2} X 60 X 15^2 X \frac{1}{3}$ — $\frac{15}{3}$ — 11250

42014.1 — 484442.6

Assume no uplift

PRC Harris, Inc.
CONSULTING ENGINEERS

SUBJECT Maccapin Reservoir
High Dam - Water to 587.4
COMPUTED BY HA CHECKED BY JP

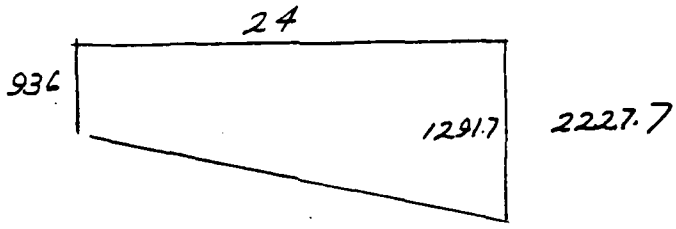
SHEET NO. 12 OF 14
JOB NO. 10A630
DATE April 15, 1990

$$\chi = \frac{1289717.2 - 494442.6}{98004.2} = 8.21$$

Sliding $\frac{98004.2 \times .6 + 20250}{42014.1 - 7020} = 2.26$

Consider Uplift

$62.4 \times 35.7 = 2227.7$
$62.4 \times 15 = \underline{936}$
$1291.7$




15500.4

$\frac{1291.7 \times 24}{2}$ 22464

$936 \times 24$ 37964.4

$\frac{2 \times 24}{3}$

$\frac{24}{2}$

248006.4

269568

517574.4

$$\chi = \frac{1289717.2 - 464442.6 - 517574.4}{98004.2 - 37964.4} = 4.79$$

Sliding $\frac{(98004.2 - 37964.4) .6 + 20250}{42014.1 - 7020} = 1.61$

PRC Harris, Inc.
CONSULTING ENGINEERS

SUBJECT Macopin Reservoir
Spillway - Water to 587.4
COMPUTED BY HK CHECKED BY JP

SHEET No. 13 OF 14
JOB No. 1RAE301
DATE April 15, 1980

Water reduction 587.14 to 557.4 = 0.7 See Sheet 8 and 9

| | | | |
|---|---|---|---|
| $0.7 \times (14.83 - 11.5) \times 62.4$ (3.33) | 145.45 | $11.5 + \frac{3.33}{2}$ | 1914.8 |
| $(4.4 - 0.7) \times 6.5 \times 62.4$ | 1500.7 | $5 + \frac{2 \times 6.5}{3}$ | 12505.8 |
| | − 1646.2 | | − 14420.6 |
| Sheet 9 | 36671.6 | | 289501 |
| Σ | 35225.4 | | 275080.4 |

Overturning

| | | | |
|---|---|---|---|
| $\frac{1}{2} \times 20^2 \times 62.4$ | 12460 | $\frac{20}{3}$ | 83200 |
| $3.7 \times 62.4 \times 20$ | 4617.6 | $\frac{20}{2}$ | 46176 |
| Earth $\frac{1}{2} \times 60 \times 3^2 \times \frac{1}{3}$ | 90 | $\frac{3}{3}$ | 90. |
| | 17187.6 | | 129466 |

Righting

| | |
|---|---|
| 35225.4 ↓ | 275080.4 |
| Sheet 9 → 280.8 $H_2O$ | 280.8 |
| → 810 Soil | 810 |
| | 276171.2 |

Assume No Uplift

$$x = \frac{276171.2 - 129466}{35225.4} = 4.16$$

PRC Harris, Inc.
CONSULTING ENGINEERS

SUBJECT Macapin Reservoir
Spillway - Water to 592.4
COMPUTED BY HX CHECKED BY JP

SHEET No. 14 OF 14
JOB No. 10A8301
DATE April 15, 1980

Sliding $\frac{35225.4 \times .7 + 810}{17187.6 - 280.8} = 1.51$

Consider Uplift

$62.4 \times 3 = 187.2$
$62.4 \times 23.7 = 1478.9$
$1291.7$

$2776.2$
$187.2 \times 14.83$
$9578$
$\frac{1291.7 \times 1463}{2}$
$12354.2$ ↑

$\frac{14.83}{2}$

$\frac{2 \times 14.83}{3}$

$20,5853$

$94694.1$

$115279.4$
$129466.0$
$244745.4$

$$\gamma = \frac{276171.2 - 244745.4}{35225.4 - 12354.2} = 1.37 \text{ ?}$$

Sliding $\frac{(35225.4 - 12354.2) .7 + 810}{17187.6 - 280.8} = 1.00$